UNDERSTANDING THE DETERMINANTS OF DECLINING UNDER-FIVE MORTALITY IN NIGERIA BETWEEN 2008 AND 2013

by
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ABSTRACT

Under-five mortality remains high in Nigeria. The country did not meet Millennium Development Goal 4. Knowledge of the determinants of under-five mortality are essential for the design of intervention programs that reduce under-five mortality. In countries with high mortality, universal coverage of key health interventions e.g. newborn care, child nutrition, vaccines; management of childhood illnesses could reduce the number of under-five deaths by more than half. Wide variations exist in the coverage of these interventions across geo-political zones in Nigeria. Determining and prioritizing the interventions driving the decline in child mortality will inform Nigeria as it drives towards the Sustainable Development Goals.

This thesis is a retrospective analysis of the different nationally representative household surveys conducted between 2008 and 2013 in Nigeria. Univariate and multivariate logistic regression models were used to explore the effects of selected socio-economic variables on under-five mortality. The Lives Saved Tool was used to determine the additional lives of under-five children saved between 2008 and 2013 based on changes in coverage of health interventions both at the national and subnational levels. The missed opportunity tool was then used to identify interventions with the highest impact for under-five children in each geo-political zone in Nigeria.

This study revealed rural-urban and geo-political zone differences in under-five mortality. There were also more deaths among children of mothers with less than secondary education and children from the poor wealth quintiles. A total of 370,000 additional lives of under-five children were saved between 2008 and 2013 with 50

percent attributable to household protection from malaria and 25 percent attributable to Vitamin A supplementation. 61 percent of the additional lives saved were from the North-East and North-West zones. ACTs for the treatment of malaria has the potential to avert the most number of deaths across all geo-political zones.

This study shows that while progress has been made to some extent, socioeconomic factors continue to play a role in under-five mortality in Nigeria, while significant improvements need to be made to drive the uptake of health interventions in the country in order to achieve the SDGs.

Readers: Dr. Bill Brieger (advisor), Dr. Henry Mosley, Dr. Kenrad Nelson, Dr. Neff Walker, Dr. Olakunle Alonge

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INTRODUCTION

Child mortality is an important measure of health and development of any society. Reduction of Under-5 mortality rate (U5MR), a Millennium Development Goal (MDG) indicator, remains a target for the Sustainable Development Goals (SDG). Globally the most common cause of under-five death is preterm birth complications and achieving the goal for U5MR require universal coverage of key interventions e.g. care for newborns, infant and young child feeding; vaccines; management of pneumonia and diarrhea; malaria control etc. In countries with high mortality, these interventions could reduce the number of deaths by more than half (WHO 2015b).

Based on recent estimates, child mortality has been declining worldwide and while this progress is commendable, it is unequally distributed with other WHO region's U5MR declining faster than the WHO African region. With the WHO African Region having an increasing share of under-5 deaths, understanding the drivers of mortality in this region becomes pertinent especially in countries that have a high burden of under-five mortality. With Nigeria contributing to 13% of all under-five deaths, it is a country of interest towards the global push for reduction in under-5 mortality rates.

Despite not meeting the MDG4 target, U5MR in Nigeria has declined from 140 to 116 deaths per 1,000 live births between 2008 and 2013. However, the question remains of what Nigeria needs to do to accelerate decline in its U5MR. This doctoral dissertation aimed to understand the drivers of this decline and as such provide evidence for what the country needs to focus on to further accelerate this decline. This dissertation is made up of three papers. The first paper looked at the socioeconomic and contextual factors affecting the odds of under-five mortality in Nigeria. The

second paper studied and identified the various child health interventions driving the decline in child mortality both at the national and sub-national levels. Regarding the heterogeneous nature of Nigeria, the third paper explored the child health interventions that will have the most impact in each of the six different geo-political zones in Nigeria.

This dissertation used various existing theories and frameworks including the Mosley and Chen framework to study the contextual factors affecting under-five mortality, the Lives Saved Tool (LiST) to study the child health interventions responsible for the reduction in mortality, the Missed Opportunity tool with the LiST to identify significant interventions in each geo-political zone. Data for these studies were from nationally representative surveys in Nigeria including the Nigerian Demographic and Health surveys of 2008 and 2013; the Malaria Indicator survey of 2010 and the 2011 Multiple Indicator Cluster survey.

This thesis is divided into five major sections. The first part discusses the background for this research. It focuses on the definition of U5MR and the global trends and causes of U5MR while bringing it home to the focus country Nigeria and Nigeria's efforts at reducing under-five mortality. The next section discusses the research objective with the specific questions that this thesis addressed. The third section describes the conceptual framework for this research and discusses the literature available on this topics. The fourth section presents the three papers while the fifth and final section ties the findings from the three papers together.

This overall goal of this study was to provide empirical evidence for the child interventions critical to Nigeria achieving the SDG 2030 target for U5MR and also to

provide evidence pertaining the relationship between the contextual factors necessary for this to happen and child mortality. As Nigeria goes ahead to develop and implement a new National Strategic Health Development Plan, the hope is that this study will provide evidence needed to plan towards achievable goals and health status in the country.

BACKGROUND

This section provides a background on under-five mortality describing the significance of measuring Under-5 mortality rate and how it is measured with a discussion on the global trend and causes of Under-5 mortality. It will also present an overview of the Nigerian context, describing the country and its relevant sectors, highlighting the trend and causes of under-five mortality in Nigeria and discussing the country's efforts at reducing under-five mortality.

CHILD MORTALITY

Child mortality is an important measure of health and development of any society. It is often assessed by Under-five mortality rate (U5MR) which is a millennium development goal indicator that measures child survival reflecting the social, economic and environmental conditions in which children live as well as their health care (WHO 2010). By definition, U5MR is the "probability of per 1,000 that a newborn baby will die before reaching age five, if subject to current age-specific mortality rates" (Hill, Pande et al. 1999).

U5MR is a better indicator for assessing the development of a society because; a) it is a measure of the outcome (mortality) of a development process rather than an input e.g. number of trained health workers, b) it is an effect of different inputs e.g. nutritional status, mother's education, health care interventions, household income, c) it is not susceptible to the fallacy of average i.e. it less likely for the mortality rate of the wealthy to affect the national mortality (UNICEF 2007a). Significantly, 90% of global deaths among children less than 18 years of age is captured by the U5MR (UNDG 2003).

The aim of the UN Millennium Development Goal 4 (MDG4) is to reduce mortality in children younger than 5 years by two-thirds between 1990 and 2015 (UN General Assembly 2000) and the Sustainable Development Goals targets for goal 3 include all countries aiming to reduce under-5 mortality to at least as low as 25 per 1,000 live births by 2030 (United Nations 2015). Global commitment to reduction in U5MR underlies the importance of U5MR; several international conference and summits have adopted goals for reduction of U5MR including: World Summit for Children (1990), the International Conference on Population and Development (1994) the Fourth World Conference on Women (1995), the World Summit for Social Development (1995), and the United Nations Millennium Summit; some have even set very ambitious goals for reduction of U5MR with the Program of Action of the International Conference on Population and Development (ICPD) pushing for countries to achieve U5MR of less than 45 deaths per 1000 births by 2015 (United Nations 2001). U5MR is also used to identify least developed countries within the United Nations as it is included in the calculation of the Human Assets Index (Closset, Feindouno et al. 2014).

With the significance of the U5MR as an indicator of the health status and development of a country, sound measurement is needed so that countries can learn where they stand and thus make extra effort to be able to accelerate the rate of decline in under-5 mortality. Mathematically, under-five mortality rate is expressed as:

$$\frac{number\ of\ deaths\ of\ children\ 0-5\ years\ in\ a\ given\ period\ of\ time}{total\ number\ of\ live\ births\ in\ the\ same\ period\ of\ time} \times 1000$$

How U5MR is calculated depends on the source of data. At the country level, U5MR can easily be calculated from vital registration systems, if it is complete. Information

on deaths of children less than five years is collected and calculated against the population of children exposed to the risk of dying. In countries where the vital registration system do not exist or is incomplete as is the case with most developing countries, other methods are applied to calculate U5MR. One of the methods that can be used in this situation includes the prospective sample survey; where a representative sample of the population is followed over a period of time, vital events are recorded over time and rates of these event are then calculated and extrapolated to the entire population (United Nations 1992). This method while similar to the vital registration systems method is not widely used because it is expensive and requires close monitoring over a long period of time.

The most conventional method for measuring U5MR which is often employed in nationally representative household surveys involves using the direct method. Surveys using the direct method collects data on full birth history from women of child bearing age asking for information on the date of birth, age of death (if dead) of every child born alive by the woman (Silva 2012). The U5MR is then calculated by applying the deaths to the exposure time (person years lived) of reported children.

Another method also used by some household surveys is the indirect method or the Brass method. This method collects very few information from women of child bearing age (her age, total number of children born and number died), it then calculates U5MR based on the particular age group of the mother using the age of the mother as a proxy for the exposure risk of her child (Graham, Brass et al. 1989). Estimates from birth history often suffer from misreporting of the both birth dates and deaths more especially when the child is dead and when there has been a long time between the event and the time of the survey. Despite this, estimates from nationally

representative household surveys using full birth history are a reliable source of U5MR especially in developing countries that don't have complete vital registration systems (United Nations 2001).

Annual estimates of U5MR are usually produced (beyond the measured U5MR from in-country surveys) by two institutions — the UN Inter-agency Group for Child Mortality Estimation (IGME) and the Institute for Health Metrics and Evaluation (IHME), though they are similar at the global level, they do differ at country level and the difference is due to the different data sources and methods used by each institution (Alkema and You 2012). These annual estimates are useful to establish trends but are often different from the rates measured by single surveys of countries because they use multiple data sources to produce estimates.

CAUSES OF UNDER-FIVE DEATHS AND GLOBAL TRENDS OF UNDER-FIVE MORTALITY RATE

Along with deaths during the neonatal period, pneumonia, diarrhea and malaria contributed to 73% of all child deaths in 2013 with preterm birth complications being the highest identified cause of death at 15% (Figure 1 (Liu, Oza et al. 2015)) . Globally

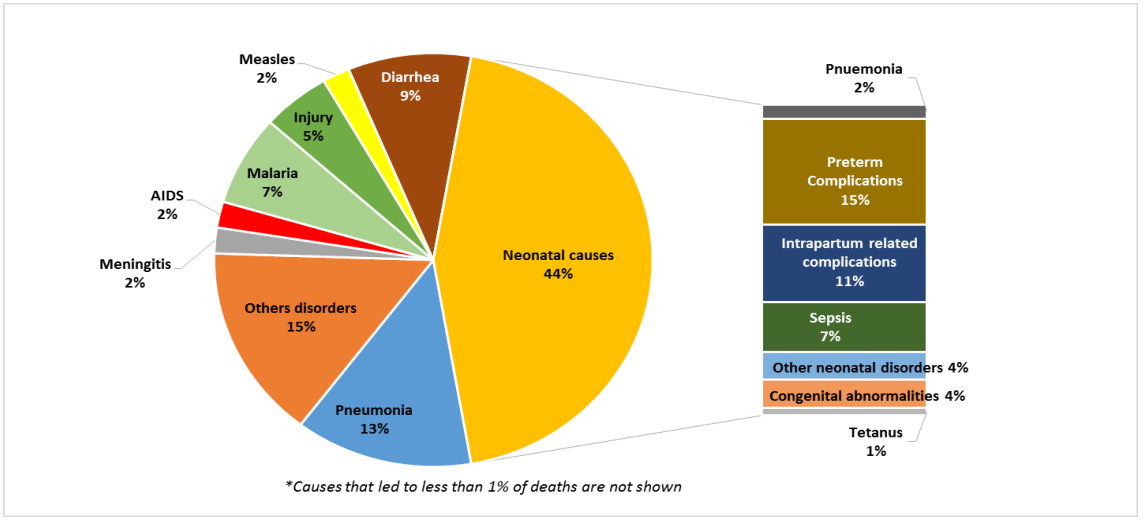


Figure 1: Global causes of childhood deaths in 2013

the most common cause of death of children less than five years of age is preterm birth complications (Liu, Oza et al. 2015) and since the MDG aimed at reducing child mortality by two thirds by 2015 from the 1990 level and the SDG targets an under-5 mortality at least as low as 25 per 1,000 live births for all countries by 2030, achieving this will require universal coverage with key effective, affordable interventions: care for newborns and their mothers; infant and young child feeding; vaccines; prevention and case management of pneumonia, diarrhea and sepsis; malaria control; and prevention and care of HIV/AIDS. In countries with high mortality, these interventions could reduce the number of deaths by more than half (WHO 2015b).

While these are the diseases that cause mortality and interventions that prevent them, several factors mediate the risk for these diseases and these include; poverty, maternal education; availability, accessibility and quality of health services; environmental risks including access to safe water and sanitation; and nutrition and the level of these factors differ by countries.

Figure 2 (WHO 2015a) shows that based on recent estimates, child mortality has been declining worldwide due to socioeconomic development and implementation of child

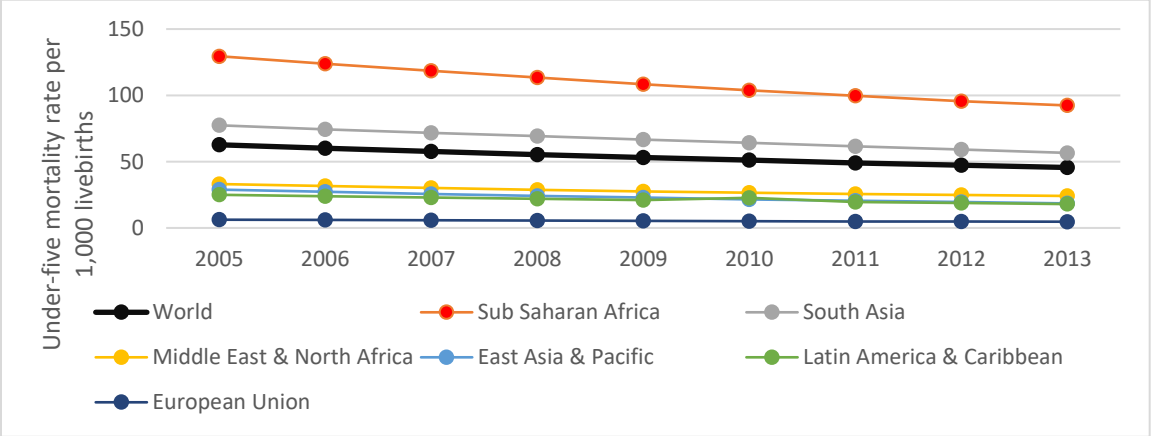


Figure 2: Global Trends of Under-five Mortality Rate

survival interventions, however, 6.3 million children still died before their fifth birthday in 2013 (Liu, Oza et al. 2015).

At an estimated 43 deaths per 1,000 live births in 2015, global U5MR has decreased by 53% from 91 deaths per 1,000 live births in 1990 (You, Hug et al. 2015). There has also been an increase in the rate of reduction – from 1.8% per year over the period of 1990 – 2000 to 3.9% per year for 2000 – 2015, about 19,000 fewer children die per day in 2015 than in 1990, however, this remains insufficient to meet the MDG 4 (WHO 2015b).

While progress has been made in reduction of U5MR, it is unequally distributed; rates of declines of U5MR between 1990 and 2013 in three WHO regions (the Americas, European and the Western Pacific) have been over 60% (WHO 2015b). The implication of this is that other regions like the WHO African region will have an increasing burden of global under-five deaths despite decreasing U5MR in the region as shown in Figure 3 (WHO 2015d) and as evidenced by sub-Saharan African children being 15 times more likely to die before their fifth birthday than children of in developed regions (WHO 2015c).

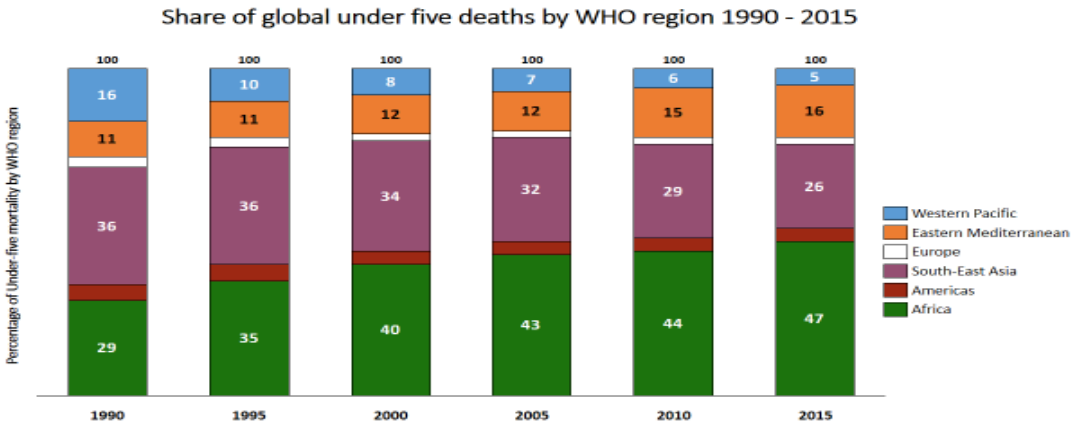


Figure 3: Distribution of Under-five deaths by WHO regions

Reports on gender differences for under five mortality have been mixed. A study reported that girls have an advantage towards surviving to five years in majority of developing countries in Sub Saharan Africa (United Nations and Division 2011) while another study reported that girls had disadvantage towards surviving to their fifth birthday in China and India and explained that these differences may be due to girls having a biological advantage at birth and then gender discrimination against girls after birth (Sawyer 2012).

Countries in the WHO African Region still have high under-five mortality – six of the seven countries with U5MR higher than 100 deaths per 1,000 live births belong to this region – and U5MR is highest in the WHO African Region (81 per 1000 live births), about 7 times higher than that in the WHO European Region (11 per 1000 live births) (WHO 2015a). As a result, it is pertinent to understand the drivers of mortality in this region and what efforts are needed to push a decline in under-five mortality in this region if it is to meet the SDGs of 2030. Looking specifically at countries, about half of global under-five deaths occur in only five countries: China, Democratic Republic of the Congo, India, Nigeria and Pakistan, with India (21%) and Nigeria (13%) together accounting for more than a third of all under-five deaths (WHO 2015c). With Nigeria contributing to 13% of global under-5 deaths, it is a country of interest towards the global push for reduction in under-five mortality rates.

NIGERIA CONTEXT

HISTORY AND GEOGRAPHY:

Nigeria, officially the Federal republic of Nigeria, is a federal constitutional republic comprising 36 states and its Federal Capital Territory, Abuja. Present-day Nigeria has been the site of numerous kingdoms and tribal states spanning over a millennium.

The country has its origins in British colonization during the late 19th to early 20th centuries, with the merging of the Southern Nigeria Protectorate and Northern Nigeria Protectorate to become one country Nigeria in 1914. The country achieved independence in 1960, and is currently sixteen years into her third democracy after two republics have been truncated by military rule. It is located in West Africa and shares land borders with the Republic of Benin in the west, Chad and Cameroon in the east and Niger in the North. Its coast in the south lies on the Gulf of the Guinea in the Atlantic Ocean.

Nigeria has a total area of 923,768 km^2 (356,669 sq. mi), making it the world's 32nd-largest country and its highest point is Chappal Waddi at 2,419 m (7,936 ft.) (CIA 1999). The main rivers are the River Niger and the River Benue which converge at Lokoja and empty into the Niger Delta which is one of the world's largest river deltas, and the location of a large area of Central African Mangroves. Nigeria has a varied landscape and climate. Climate is equatorial in the south, tropical in the center and arid in north. The far south is defined by its tropical rainforest climate, where annual rainfall is 60 to 80 inches (1,500 to 2,000 mm) a year. Everything in between the far south and the far north, is savannah (insignificant tree cover, with grasses and flowers located between trees) with rainfall being more limited, to between 20 and 60 inches (500 to 1,500 mm) per year (GAI 2007). Major cities in Nigeria include; Abuja (the federal capital territory), Lagos, Kano, Ibadan, Port Harcourt, Enugu and Kaduna.

SUBDIVISIONS:

Nigeria is divided administratively into thirty-six states and one Federal Capital Territory (FCT) that are further sub-divided into 774 Local Government Areas (LGAs). The country has a tumultuous history and the difficulties in managing a heterogeneous national entity at all levels of government. Politically, these states and the FCT are grouped into six geopolitical zones based on proximity: North-Central, North-East, North-West, South-East, South-South, and South-West (Figure 4). The majority of the country's land mass is in the North as can be seen in Figure. 4, however based on the disputed 2006 census (NPC Nigeria 2007, Okafor, Adeleke et al. 2007, Bamgbose 2009), 46% of the population reside in the South.

DEMOGRAPHY

Nigeria is often referred to as the "Giant of Africa", owing to its large population and economy. With a 2013 estimated population of approximately 173 million inhabitants,

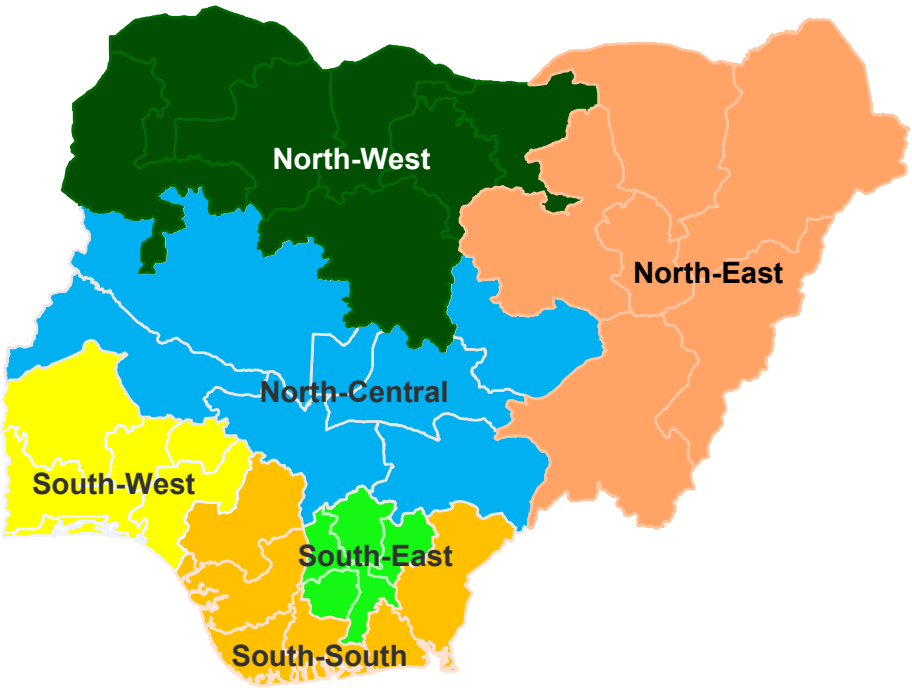


Figure 4: Geopolitical zones of Nigeria

Nigeria is the most populous country in Africa and the seventh most populous country in the world (World Bank 2015b).

The country is inhabited by over 500 ethnic groups, of which the three largest are the Hausa, Yoruba and Igbo. Regarding religion, Nigeria is divided roughly in half between Christians, who live mostly in the southern and central parts of the country, and Muslims, concentrated mostly in the northern and southwestern regions.

Population in Nigeria increased from 1990 to 2008 by 57 million; a 60% growth rate (Babalola 2012). The United Nations estimates that the population in 2009 was at 154,729,000, distributed as 51.7% rural and 48.3% urban, and with a population density of 167.5 people per square kilometer (Babalola 2012). National census results in the past few decades have been disputed because census figures are used to determine regional funding and representation of ethnic and religious groups in government service. This provides an incentive for inflating local populations. Census figures are believed to have been manipulated in the past for political advantage (Bamgbose 2009).

The results of the most recent census were released in December 2006 and gave a population of 140,003,542 with 71,709,859 males (51%) and 68,293,683 females (49%). According to the 2013 Demographic and Health Survey (DHS), 46% of Nigerians are less than 15 years with 17% being less than 5 years as shown in Figure 5.

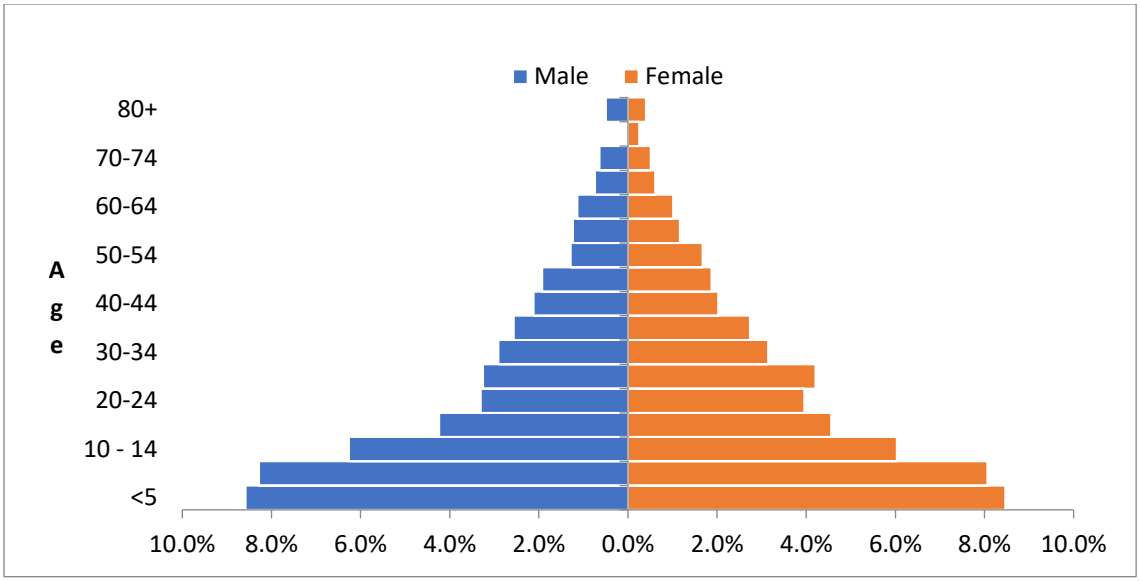


Figure 5: Population Pyramid of Nigeria 2013

According to the United Nations, Nigeria has been undergoing explosive population growth and has one of the highest growth and fertility rates in the world and by their projections, Nigeria is one of eight countries expected to account collectively for half of the world's total population increase from 2005–2050 (Babalola 2012). Table 1 further describes the country's demographic profile.

Table 1: Demographic and Health Indices of Nigeria

Indicator	**Estimate**	**Compared to the World**
Population Growth Rate	2.47%	33rd
Median Age	18.2 years	N/A
Total Population Literate	61.3%	N/A
Life Expectancy	52.62 years	212th
Crude Birth Rate	38.03 births/1000 population	12th
Crude Death Rate	13.16 deaths/1000 population	19th
Total Fertility Rate	5.5	9th
Maternal Mortality Ratio	545 deaths/100,000 live births	16th
Infant Mortality Rate	69 deaths/1,000 live births	15th
HIV Prevalence	3.1%	20th

Nigeria demographic profile also differ across the six geo-political zones in the country as listed in table 2.

Table 2: Subnational Demographic Profile

	2006 Population	Total Fertility Rate	Contraceptive Prevalence rate
North Central	20,266,257	5.3	15.6
North East	18,971,965	6.3	3.2
North West	35,786,944	6.7	4.3
South East	16,381,729	4.7	29.3
South South	21,014,655	4.3	28.1
South West	27,581,992	4.6	38.0
Nigeria	140,003,542	5.5	15.1

* - CPR – percentage of women in a union using any method of contraception

It is also important to point out that the population of children under-five increased from 16.8 million to 29.7 million between 1990 and 2013 (Gapminder 2017). With TFR plateauing, this rate of increase is bound to continue and will have impact in the coverage of interventions targeting the under-five population as the target population keeps increasing.

ECONOMY

In April 2014, following a rebasing exercise, Nigeria's economy (GDP) became the largest in Africa, worth more than $500 billion, and overtook South Africa to become the world's 21st largest economy (Magnowski 2014). The country's oil reserves have played a major role in its growing wealth and influence, however, a GDP per capita of $3005 (World Bank 2015c) and Human Development Index of 0.504 (152nd in the world)(Malik 2014) reflect the unequal and poor socio-economic development of the country. Nigeria is considered to be an emerging market by the World Bank and has been identified as a regional power in Africa. It is also a member of the MINT group of countries.

Before the re-basing exercise, the Nigerian economy was growing at a rate of rapid 6-8% per annum from diversification into agriculture, telecommunications, entertainment and services (CIA 2015). "Despite its strong fundamentals, oil-rich Nigeria has been hobbled by inadequate power supply, lack of infrastructure, delays in the passage of legislative reforms, an inefficient property registration system, restrictive trade policies, an inconsistent regulatory environment, a slow and ineffective judicial system, unreliable dispute resolution mechanisms, insecurity, and pervasive corruption" – the effects of the growing economy has not reflected in substantial decline in poverty levels; over 62% of Nigeria's 170 million people live in extreme poverty (CIA 2015). And with the current declining of oil prices and change in government, the diversification of the Nigerian economy needs to be continued and hopefully will address the issues of poverty in the country.

HEALTH STATUS, SECTOR AND SERVICES

Nigeria has a large but under-performing health system which has struggled in improving the countries health indicators as seen in Table 1. Nigeria's average population health outcomes are relatively low compared to other countries with similar levels of resources and endowments. With a maternal mortality ratio of 576

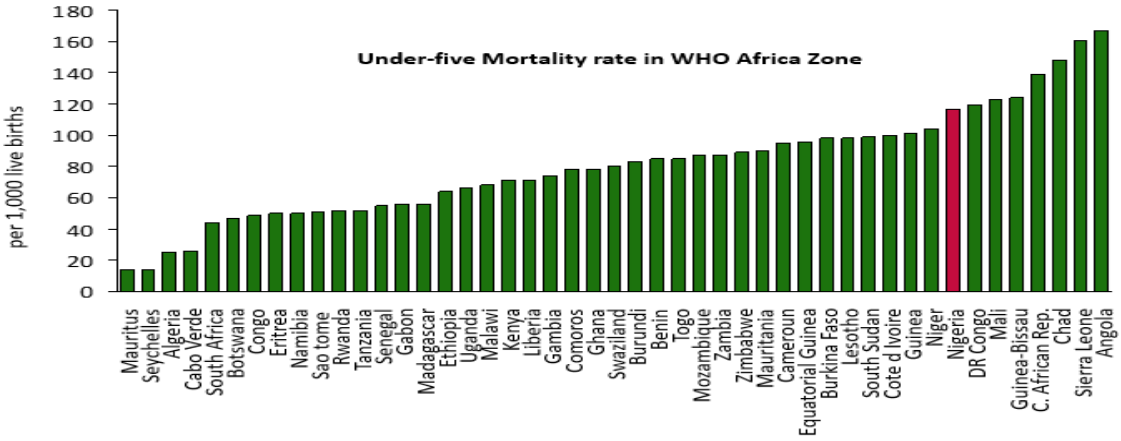


Figure 6: Under-five Mortality rate by WHO Africa zone

for 100,000 live births (NPC Nigeria 2014), Nigeria contributes towards 10 percent of world's maternal deaths (USAID 2015) and with an Under-five mortality rate of at 129 per 1,000 live births, Nigeria (13%) along with India (21%) account for more than one-third of deaths among children below 5 years of age. Out of the 47 countries the WHO African region, Nigeria's U5MR is only better than 7 countries (Figure 6) (WHO 2015e).

Nigeria's health system is a fiscally decentralized system of government whereby Federal, States and Local Governments all have concurrent constitutional responsibility regarding health, yet there are no intergovernmental accountability mechanisms. Whilst the national health policy of 2004 places implementation of primary health care to the weakest link, the Local governments, Federal and State governments are not absolved of the responsibility to improve the health of Nigerians. This structural constraint is to be addressed by the new national health bill that was passed in 2014.

UNDER-FIVE MORTALITY RATE IN NIGERIA

For statistics, Nigeria relies on household surveys like the Demographic and Health Surveys, Multiples Indicator Cluster surveys, and some specialized surveys for population estimates of health intervention coverage as well as its estimate of Under-five mortality rate. The Demographic and Health Surveys (DHS) conducted in Nigeria show that U5MR in Nigeria has been declining from 201 in 2003 to 157 in 2008 and 128 per 1,000 live births in 2013 (NPC Nigeria 2014). However, despite substantial investment in health and total health expenditure of 5 percent of GDP, surveys show limited progress have been made in most key maternal, newborn and child health indicators over the last few years. For example, comparing the different Demographic

and Health Surveys conducted in the country, population coverage for skill birth attendance at delivery fell from 38.9% in 2008 to 38.1% in 2013 while percent of children in the aged 12-23 months who received all basic vaccinations increased from 22.7% in 2008 to 25.3% in 2013. Similarly, measles vaccination coverage increased only by 0.7 percentage points (41.4% – 42.1%). In addition, disparities within the geopolitical zones and the individual states are stark with the northern zones and states faring worse off than southern zones and states as can be seen in Fig. 7 and 8. For example, U5MR in the North West zone is 185 per 1,000 live births while it is 90 per 1,000 live births in the South West zone, and in terms of health intervention coverage, in the North West zone only 10% of children in the age group of 12-23 months are fully vaccinated, as compared to almost 41% in the South-West zone.

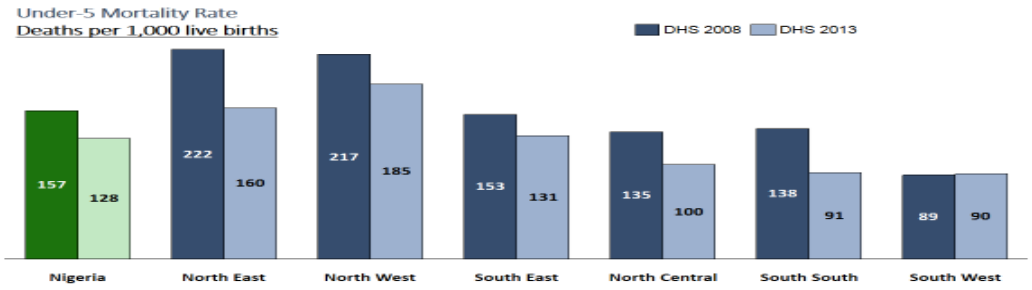


Figure 7: Under-five Mortality rate by Geopolitical zones in Nigeria

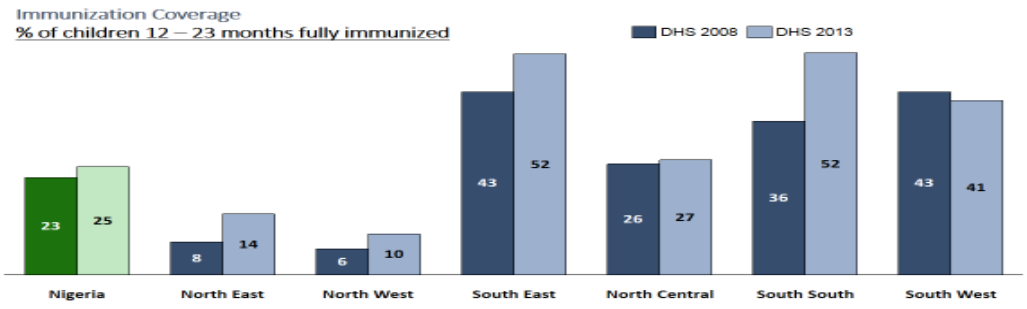


Figure 8: Immunization coverage by Geopolitical zones in Nigeria

CAUSES OF UNDER-FIVE MORTALITY IN NIGERIA

The major cause of death for children under five years of age in Nigeria is malaria accounting 21% of all deaths of children less than 5 years old (Figure 9) (WHO 2014). 64% of deaths of children under five years of age in Nigeria are due to 3 major illnesses; Malaria, Pneumonia and Diarrhea.

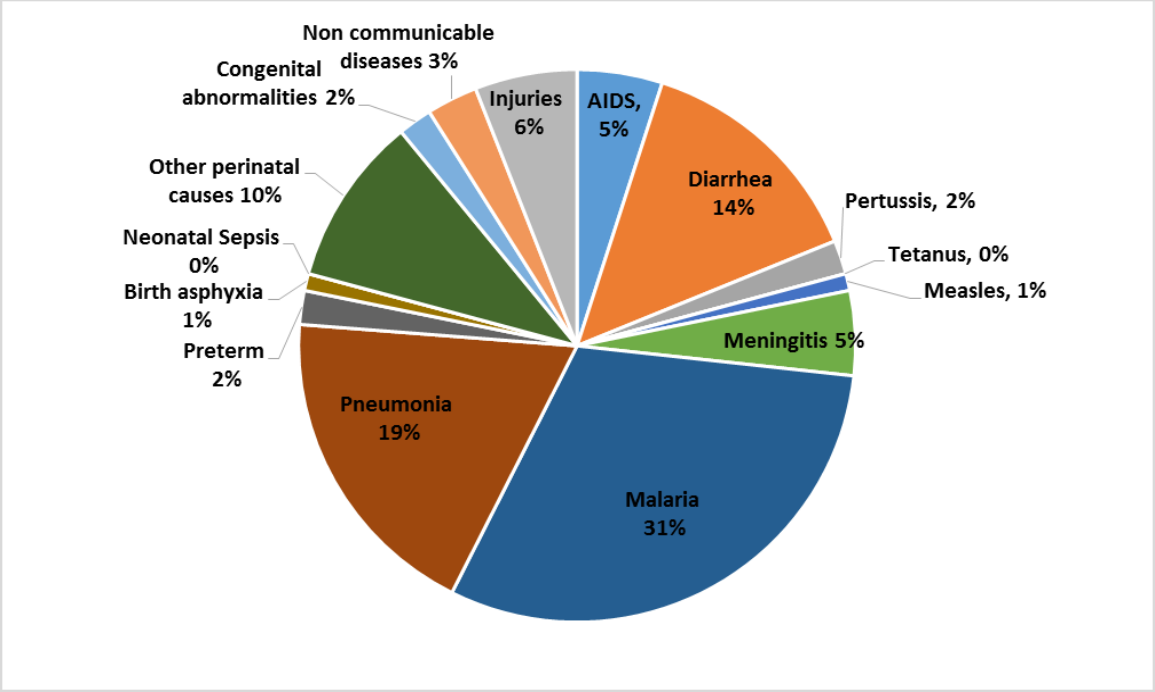


Figure 9: Causes of Under-five deaths in Nigeria in 2013

Studies about causes of death at the state level has been few and limited to research conducted by university staff and has not been widely published. The assumption is that causes of death are not significantly different across the states and geopolitical zones of Nigeria.

NIGERIA'S EFFORTS AT REDUCING UNDER-FIVE MORTALITY

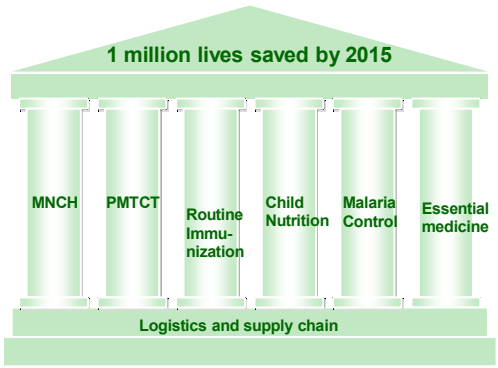
The Nigerian government has made efforts at combatting causes of deaths of children less than five years of age. Policies have been set and programs implemented to address these issues. One significant policy is the National child health policy of 2006

which covers newborn, under five and school age children. This national child health policy sets forth priorities, strategies and interventions necessary to overcome the challenges of child health care such as measles, diarrhea, acute respiratory infections, malnutrition, low birth weight, asphyxia, sepsis, neonatal jaundice and neonatal tetanus, malaria and helminthic infections like ascariasis and schistosomiasis. Other policies from other sectors like the free education for children in public schools by the Ministry of Education have also intended to address challenges facing children under five

In terms of implementation of interventions, Nigeria has set up several agencies and programs to implement these policies. These include; National Primary Health Care Development Agency (NPHCDA), National Malaria Control Program (NMCP), Midwives Service Scheme, Subsidy Reinvestment and Empowerment Program (SURE-P), Saving One Million Lives Initiative (SOML), National Program on Immunization (NPI), Integrated Management of Childhood Illnesses (IMCI) etc. The NPHCDA is a body that runs the primary health care system in Nigeria. Established in 2001, it has state arms in about 21 states of the federation and implements most health programs targeting mothers and children at the primary health care level. Programs carried out by the NPHCDA include the Maternal, Newborn and Child Health weeks (MNCH weeks) where immunizations are given to missed opportunity children as well other health interventions like family planning, Oral Rehydration Therapy, child nutrition interventions like identifying and managing malnourished children, Vitamin A supplementation and deworming are given out as well as identifying and treating of children with respiratory tract infections.

The NMCP was established in 2001 and became the National Malaria Elimination Program (NMEP) in 2014 with a specific aim of tackling malaria by prevention through distribution of long lasting insecticide treated nets, diagnosis using rapid diagnostic test kits and treatment with Artemisinin based Combination Therapy (ACT).

In addition to these agencies and programs, the government have also tried to accelerate Nigeria's progress towards the MDG 4 with some unique initiatives that specifically target mothers and children. Some of these are Midwives Service Scheme (MSS), a program which aims to increase the availability of skilled birth attendants in underserved regions of the country, the SURE-P Maternal, Newborn and Child Health program which while improving human resources for health also improves demand for health care through innovations like conditional cash transfers (CCT) to boost demand for MNCH services and the Saving One Million Lives Initiative (SOML) which was launched in 2012 with a goal of driving and accentuating the efforts of the Federal Ministry of Health towards saving an additional one million lives of children under five years and women of child bearing age by 2015. The SOML is not a new health program but rather builds on existing policies, strategic documents and frameworks as outlined by the National Strategic Health Development Plan and the President's Transformation Agenda and aims at shifting the focus of health care delivery in Nigeria from inputs to focusing on results and outcomes with better coordination and engagement across agencies, between different tiers of government and amongst development partners. The initiative aims to set



targets for and track the country's performance on key maternal and child health interventions grouped into six pillars; Maternal, Newborn and Child Health pillar, Prevention of Mother to Child Transmission of HIV pillar, Access to Essential medicines pillar, Routine Immunization pillar, Child Nutrition pillar and Malaria control pillar. If the targets of these interventions are achieved by 2015, an additional one million lives of children less than five years would have been saved.

Given the different causes of mortality and considering the fact that U5MR has been on the decline in Nigeria, it is pertinent to identify the major drivers of this decline to enable the country with its various health intervention program focus on the right ones to achieve their MDG 4 and push towards the SDG target. The question that therefore needs to be answered is; what are the factors that are contributing to the decline in under five mortality in Nigeria?

In summary, Under-five mortality remains an important measure of health and development of any society and is a leading indicator of child health and overall development. While it has been declining globally over the past years, Africa trails other WHO sub regions in the rate of decline and will require a strong push to achieve the SDG target of 2030. Nigeria is a major contributor to under-five mortality accounting for 13% of all deaths of children under-five globally. The country has implemented several policies and program geared at saving lives of children under five and has recorded a decline in under five mortality, however there remains a need to understand the major drivers of this decline in order to be able to accelerate efforts towards attaining the sustainable development target for under five mortality rate of less than 25 deaths per 1,000 live births in 2030.

RESEARCH OBJECTIVES

Nigeria did not meet the MDG 4 target. Despite 5% of its GDP going to Health, population coverage levels of key maternal, newborn and child health (MNCH) interventions have not improved remarkably when comparing the 2008 DHS and 2013 DHS. The country therefore, needs to understand what factors are responsible for the decline in mortality and identify the interventions that will best accelerate this decline in U5MR towards the SDGs.

OBJECTIVE 1: **To determine the contextual factors affecting under-five mortality in Nigeria.**

With the Sustainable Development Goals (SDG) having been adopted, Nigeria needs to identify the major drivers for the declining rate of Under-five mortality if it aims to achieve the target by 2030. Various contextual factors have been proven to affect mortality; reduced poverty, environmental factors, urban versus rural dwelling, household factors and maternal education for example. The hypothesis for this objective is that increasing maternal education and improving economic status are the major drivers for the decline in Under 5 mortality in Nigeria between 2008 and 2013. Developing a framework for how geopolitical zone, urban vs. rural dwelling, household income, household size and maternal education affect mortality and running a regression model will help identify the significant variables affecting the odds of under-five mortality in Nigeria.

The specific research questions for this objective would include:

1. What are the significant contextual factors that affect the risk of child mortality?

2. Do geo-political zones affect the odds of under-five mortality in Nigeria controlling for other factors?

OBJECTIVE 2: **To determine the contribution of the various health interventions to lives saved thereby reducing under-five mortality in Nigeria between 2008 and 2013 based on the change in coverage level of health intervention as measured by nationally representative surveys.**

Comparing the population coverage of health interventions between the 2008 DHS and 2013 DHS show little or no change, however, the survey shows a decline in U5MR from 159 deaths in 2008 to 128 deaths in 2013 per 1000 live births. The Lives Saved Tool (LiST), predicts changes in mortality due to changes in coverage of specific child health care interventions. While it predicts the decline in mortality due to changes in child health care interventions, it also identifies which intervention was responsible for the most deaths averted. The hypothesis for this objective is that malaria prevention interventions contributed the most number of additional lives saved in Nigeria between 2008 and 2013.

The specific research questions for this objective would include:

1. What interventions according to the Lives Saved Tool are responsible for the most lives saved between 2008 and 2013?
2. At the subnational level what interventions contributed to the most number of lives saved?

OBJECTIVE 3: **Can Nigeria use the Lives Saved Tool to identify and prioritize health interventions required to enable the country to be able to achieve the sustainable development goal for Under 5 mortality rate?**

Despite the launch of various initiatives including the 2012 Saving One Million Lives (SOML) initiative that had a goal increasing access to significant maternal, newborn and child health interventions, mortality rate in the country remains high. Wide variations exist in coverage of health interventions and health outcomes across the geo-political zones and states in Nigeria. With the adoption of the SDGs, there has to be a clear understanding based on available evidence which key interventions would save the most number of lives of children under five in Nigeria. The LIST tool helps prioritize interventions through the missed opportunity tool that would significantly push the country towards her desired U5MR goal by geo-political zones. This research will aim to prioritize health interventions to be scaled up by geo-political zones in Nigeria.

The specific research questions for this objective would include:

1. What are the key interventions to reduce under-five mortality in each geo-political zone of Nigeria?

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

SOCIOECONOMIC DETERMINANTS OF UNDER-FIVE MORTALITY

Several frameworks have been developed to study child mortality. Most common is the Mosley and Chen 1984 analytical framework for the study of child survival in developing countries which allows for incorporating both social and biological sciences in the study of determinants of child mortality. The Mosley and Chan framework is based on the assumption that that all social and economic (distal) determinants of child mortality act through a defined set of proximate determinants with clear biological pathways to affect child mortality (Mosley and Chen 1984). They grouped these proximate factors into five categories: Maternal factors, Environmental contamination, Nutrient deficiency, Injury, and Personal illness control. Some studies have allowed for these proximate variables to affect mortality at different levels (country, household, individual etc.) and at different age groups. A study in India which developed a flexible parametric framework that allowed individual and household level characteristics to have different effects on infant and child mortality at different ages (Van der Klaauw and Wang 2004). With their framework, they were able to find out that improvement of socioeconomic status reflected through access to electricity, improving education of women, provision of sanitation facilities, and reducing indoor air pollution were able to prevent a significant number of under-five deaths. Other studies have allowed for frameworks that incorporate several variables beyond those elucidated by Mosley and Chen 1984. A study of 175 countries study stated that 51.2% of the reduction of deaths of children younger than 5 years between 1970 and 2009 could be attributed to increased educational attainment in women of reproductive age (Gakidou, Cowling et al. 2010). They also posited that substantial

increase in education of women and the reversal of gender gap have important implications for health and ensuring rapid progress towards MDG 4. The general consensus however, remains that the social, economic, biological and environmental forces all affect at different rates and at the different levels, the probability of a child surviving to their fifth birthday.

Based on the available frameworks and literature, proximate determinants affect the dynamics of a child moving from healthy to sick and consequently either growth faltering or mortality. The socioeconomic, biological and environmental determinants play a strong role in how these proximate determinants affect the healthy and sick child dynamics. The magnitude of these effects however depends on the particular society or country (developed and developing countries and societies).

Building on the Mosley and Chen framework, the analytical framework for this research objective is illustrated in Figure 10. Determinants have been categorized at

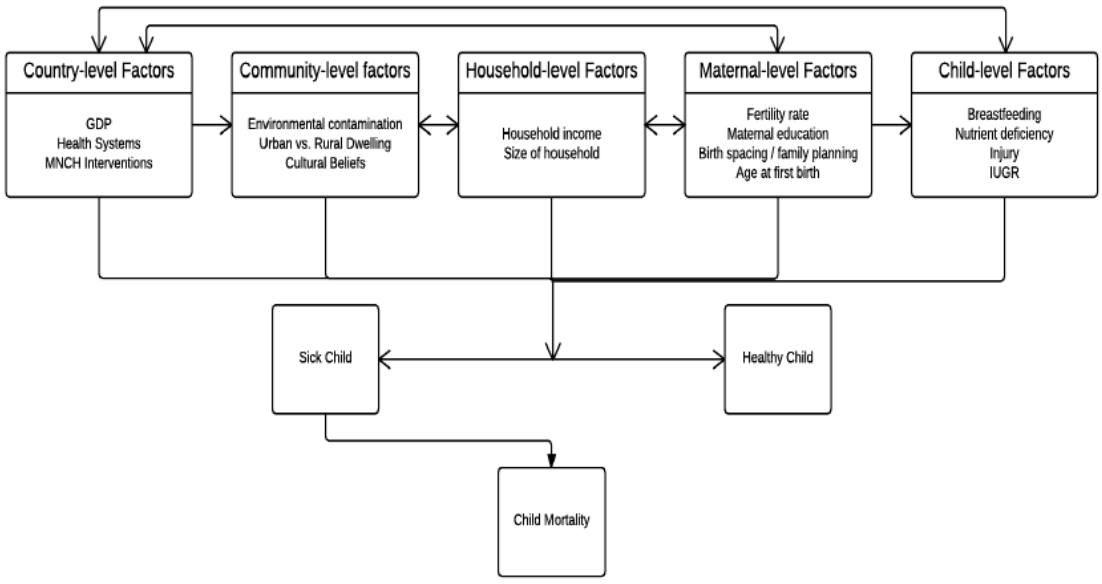


Figure 10: Conceptual framework for analyzing determinants of Child Mortality

the level where they operate maximally in affecting child mortality which is the dependent variable into; child-, maternal-, household-, and community determinants and country-level factors. Country-level factors may exert direct, cross-level effects on child mortality, exert indirect, cross-level effects mediated through more proximal variables, such as community or household socioeconomic factors, and modify the associations between independent and dependent variables operating within or across levels (e.g. country gross domestic product (GDP) modifying the effects of household-level disadvantage on child mortality). Many of these interactions may produce bidirectional effects such that family-level and maternal-level factors may influence the community- and country-level variables.

LIVES SAVED TOOL ESTIMATION

The Lives Saved Tool is a multi-cause model of mortality that predict changes in Under-five and neonatal mortality rates and deaths, maternal mortality ratios and deaths, stillbirth rates and deaths, causes of death using country specific health status, changes in child and maternal health intervention coverage levels i.e. ORS, facility delivery, etc. and effect sizes of interventions based on the best available evidence. It operates within the Spectrum software. Figure 11 shows the framework on which LiST estimates are modelled.

While *LiST* is mainly used to estimate the impact of scaling up interventions on mortality to provide evidence for the potential effectiveness of an intervention, to help in refocusing priorities, or to set targets at a global level as well as to guide the strategic planning process especially in developing countries, it can also be used to show projected reduction in mortality from measured change in coverage of health

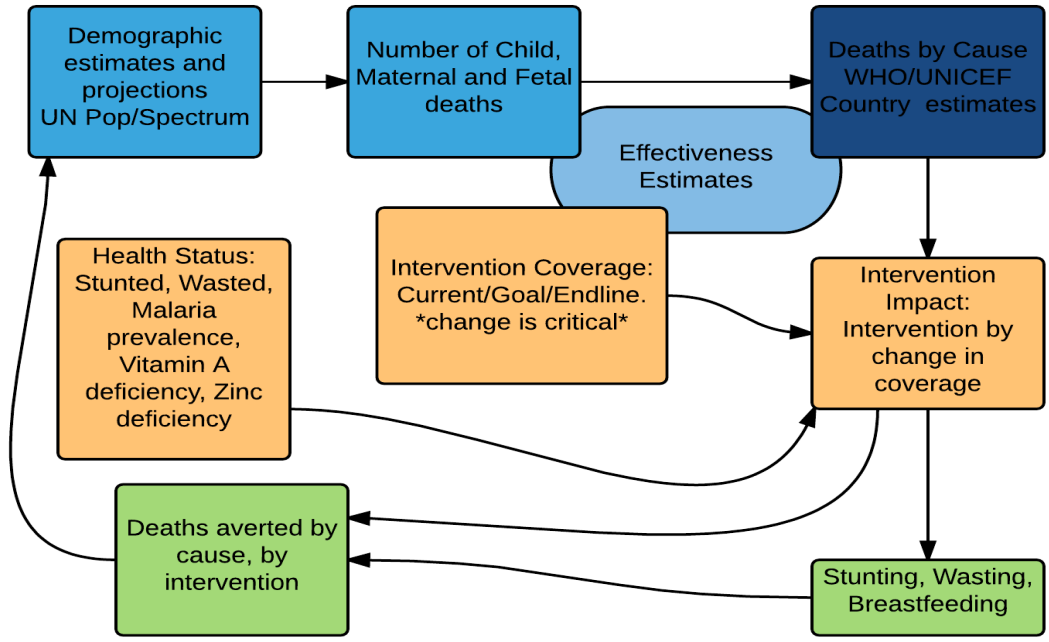


Figure 11: General Framework for LiST Modelling

interventions (Walker, Tam et al. 2013). Groups have also used the LiST to retrospectively attribute the causes of measured or observed declines in mortality to specific activities (Afnan-Holmes, Magoma et al. 2015).

The tool is built on the broad concept that based on; 1) the population of a particular country, 2) the given health status of the country and mortality rate hence the number of deaths in the country, 3) the causes of mortality specific to the country, changes in the population coverage of certain interventions based on their effectiveness will avert an estimated number of death thereby reducing mortality as shown in Figure 11. The LiST has been described as a linear mathematical model that is deterministic with a fixed relationship between inputs and outputs, leading to the same outputs each time the model is run with identical inputs (Garnett, Cousens et al. 2011). The inputs are usually coverage of interventions (baseline and target) and the outputs are changes in population-level risk factors (e.g., wasting or stunting rates) or cause-specific

mortality and age-specific mortality (e.g., Under-five mortality). A grand assumption is implied in LiST estimates and that is that mortality rates and cause of death structures in a country will not change dynamically and that the difference between the baseline year and the endline year is a response to changes in intervention coverage (Walker and Walker 2014). Another assumption is that distal variables like increases in per capita income or higher levels of maternal education cause changes in mortality through the effects of changes in coverage of interventions or by reducing risk factors other risk factors.

There are currently more than 70 different maternal and child health interventions within LiST and these are intervention along the continuum of care for child health from Peri-conceptual period through age five. Figure 12 lists the groups of interventions within the LiST model. LiST runs within the Spectrum software http://www.avenirhealth.org/software-spectrum.php as a module linked directly to

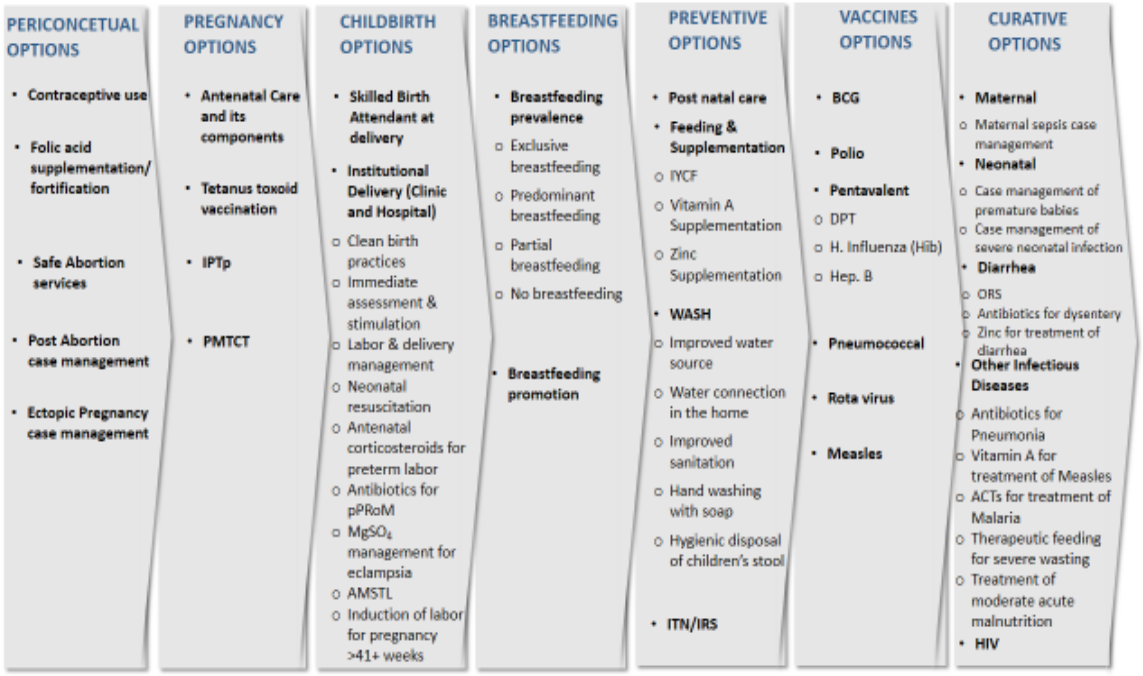


Figure 12: Interventions along the continuum of care for child health contained in the LiST

three additional modules viz demographic module, family planning module and AIDS impact module. The demographic projection is a required linkage and allows for effects of migration, population size and structure by age and sex, and other demographic factors to be reflected in the LiST output. The family planning module estimates the impact of scaling up family planning on fertility. This affects both the demographic projection and the LiST assumptions for risky births. The AIDS impact module models the impact of changes in HIV/AIDS incidence and prevalence, treatment and prevention on mortality.

LiST works by attributing lives saved/deaths averted to changes in coverage of specific interventions and risk factors based on the effectiveness of these interventions. It works by attributing impact sequentially along the continuum of care from peri-conceptual through delivery and within specific age groups. It does this first for preventive interventions then curative interventions with regards to multiple interventions that affect the same cause of death. This means that if both preventive and curative interventions for a particular cause of death are scaled up at the same time, the LiST first calculates the full effect of the preventive interventions and attributes it to the preventive interventions then any residual death averted are calculated and attributed to curative interventions based on their effectiveness (Walker, Tam et al. 2013).

To attribute deaths averted by specific interventions within the same category (preventive interventions) that affect the same cause of death, the LiST makes an additional calculation. It calculates a proportional impact of the interventions which is calculated as increase in coverage times the effectiveness of the intervention. This

proportional impact is then applied to the total deaths averted by preventive interventions. The same approach is used for multiple curative interventions (Walker, Tam et al. 2013).

The Lives Saved Tool is a reasonably reliable tool for estimating the decline in mortality due to changes in the coverage of interventions within the model and attributing lives saved to specific interventions. It however relies on data on the population coverage of health interventions and this is usually gotten from household surveys e.g. DHS, MICS etc.

PAPER 1: Effects of socio-economic determinants on under five mortality in Nigeria

ABSTRACT:

Background: Under-five mortality is a prominent public health issue particularly in developing countries including Nigeria. Knowledge of the determinants of under-five mortality are essential for the design of intervention programs aimed at reducing under-five mortality. The goal of this study was to investigate and identify maternal, household and other risk factors associated under-five mortality in Nigeria.

Methods: This was a retrospective analysis of the child health data collected in the Nigeria Demographic and Health Surveys (NDHS) of 2013. Univariate and multivariate logistic regression models were used to explore the effects of selected maternal and demographic variables on under-five mortality. The odds ratio (OR) and its 95% Confidence Interval (CI) were estimated to identify significant factors. Likelihood Ratio Test, Hosmer-Lemeshow Goodness-of-Fit and Variance Inflation Factor were used to check the fit of the model.

Results: This study revealed rural-urban and zonal differences in under-five mortality with more deaths occurring in rural areas and northern geopolitical zones of Nigeria. There were also more deaths among children of mothers with less than secondary education and children from the poorest and poorer wealth quintiles. Likelihood of under-five mortality among children in rural areas increased by 28% compared to children from urban areas and decreased by 29% among children from the South South geopolitical zone compared to children from the North West geopolitical zone. Also, the likelihood of under-five mortality was reduced by 30% and 44% among children whose mothers had secondary or higher education attainment

respectively when compared to children whose mothers had no formal education. Compared to children from the poorest wealth quintile, the odds of under-five mortality reduced by 31% among children from the richest wealth quintile. Increasing household size reduced the odds of under-five mortality (OR = 0.92; CI = 0.91 – 0.93).

Conclusions: This study has showed that geopolitical zone, area of residence, maternal education, household income and household size were important determinants of under-five mortality in Nigeria. Formulating policies and programs that will address these factors will assist Nigeria in reducing under-five mortality and improving child survival.

BACKGROUND

Under-five mortality is a prominent public health issue. 5.9 million children under the age of 5 years died in 2015 and more than half of these early child deaths were preventable (WHO 2015c). While progress has been made in the reduction of global under-five mortality, it has been unequally distributed with many countries in Sub-Saharan Africa including Nigeria still having high under-five mortality (UNCs 2014, WHO 2015b). Children in developing countries are 14 times as more likely to die before their fifth birthday compared to those in developed countries (WHO 2015c). Under-five mortality is measured as under-five mortality rate (U5MR) which is the probability of a child dying before their firth birthday. U5MR is a better indicator for assessing the development of a society because; a) it is a measure of the outcome (mortality) of a development process rather than an input e.g. number of trained health workers, b) it is an effect of different inputs e.g. nutritional status, mother's education, health care interventions, household income, c) it is not susceptible to the fallacy of average i.e. it less likely for the mortality rate of the wealthy to affect the

national mortality (UNICEF 2007a). Significantly, 90% of global deaths among children less than 18 years of age is captured by the under-five mortality rate (UNDG 2003). It goes without saying that overall success in child survival is contingent on a corresponding decline in under-five mortality.

About half of global under-five deaths occur in only five countries: China, Democratic Republic of the Congo, India, Nigeria and Pakistan, with India (21%) and Nigeria (13%) together accounting for more than a third of all under-five deaths (Vakili, Emami Moghadam et al. 2015, WHO 2015c). The Nigeria Demographic and Health Survey (NDHS) 2013 estimated its U5MR as 128 deaths per 1000 live births(Demographic 2013). Out of the 47 countries the WHO African region, Nigeria's U5MR is only better than seven countries (WHO 2015e). However, there have been improvement in Nigeria with U%MR reducing from 157 deaths per 1000 live births in 2008 to 128 per 1000 in 2013 (Demographic 2013).

Identifying determinants of under-five mortality (U5M) is essential for formulating appropriate health programs and policies in order to drive the reduction in under-five mortality particularly in Nigeria. Several studies have provided useful insights into the determinants of under-five mortality. Most of these studies were based on the Mosley and Chen 1984 analytical framework for the study of child survival (Mosley and Chen 1984) and have shown that under-five mortality is affected by socio-economic and proximate factors. Studies have identified strong associations between maternal factors and childhood mortality. They have shown that children of educated mothers will survive better than children of non-educated mothers (Caldwell 1979, Bhuiya and Streatfield 1992, Buor 2003, Basu and Stephenson 2005, Cleland and van Ginneken 2008, Cleland 2010, Gakidou, Cowling et al. 2010). However another author

has reported that maternal education has little or no effect on child survival (Hobcraft 1993) while another author reported a negative relationship in his study (Adetunji 1995).

Studies on urban-rural mortality differentials in Sub-Saharan Africa generally show that under-five mortality in particular, is generally lower in urban than in rural areas (Akoto and Tambashe 2002). Conflicting evidence exist with an author reporting that urban poor children showed poorer health outcomes and nutritional outcomes than even those in the rural areas of Kenya (Fotso 2007). Other studies however continue to show a positive relationship between urban settlements and health outcomes (Sastry 1997, Garrett and Ruel 1999, Fotso and Kuate-Defo 2005, Smith, Ruel et al. 2005).

Household income is another socio-economic determinant that affects child health and mortality through several proximate determinants. Its effects on health are influenced through ability to purchase healthcare, food, water and clothing. It also bears on the size and quality of housing and ability to afford transportation. Several studies have explored the relationship between household income and child mortality. They have demonstrated that low income status is associated with increased rates of infant and child mortality (Singh and Yu 1995, Daly, Duncan et al. 1998, Ecob and Smith 1999, Wagstaff and Van Doorslaer 2000, Safer 2004, Singh and Kogan 2007). It is important to note that there has been some mixed outcomes with an author reporting that while household income had significant effect on neonatal mortality rate in Nigeria it did not have a significant effect on infant and under-five mortality rates in Nigeria (Edeme, Ifelunini et al. 2014).

Large household size has been indicated to have a close relationship with high childhood mortality. If there are more dependents than income generating members, there is a higher risk of risk mortality through inadequate quantity and variety of food, child labor to augment household income and selective care. Studies have documented how parents reluctantly practice triage, neglecting the care of certain children who die as a result (Turnbull III 1985, Scheper-Hughes 1993), or even actively intervene to bring about death usually of daughters (Venkatramani 1986, Croll 2000). The evidence for the relationship between household size and child health has been mixed. While there is evidence for negative relationship (Jolly and Gribble 1993, Adegboyega, Ntozi et al. 1997) there has been evidence for a positive relationship (Charmarbagwala, Ranger et al. 2004). There is also evidence for no association between household size and child mortality (Kabagenyi and Rutaremwa 2013).

Some of these studies on U5MR may not be applicable to Nigeria due to differences in social, cultural and economic characteristics. Moreover, the few studies from Nigeria did not use national representative data (Feyisetan 1985, Oni 1988, Adetunji 1995, Feyisetan, Asa et al. 1997, Folasade 2000). Thus, the generalizability of the results is a serious problem in a country like Nigeria because of her diversity. Differences abound between the various cultural groups in the country. For example in some communities in Nigeria, women are frowned upon and stigmatized if they shout or show signs of discomfort during labor and this can affect the timing at which care is sought for a women going through a difficult labor and thus affect child mortality. There are also some cultural practices that are out rightly harmful to a child. For example the practice of giving cow urine or burning the feet to manage convulsions in

children and the belief that colostrum is spoilt breast milk and must not be giving to the baby (Ofodile and Oluwasanmi 1978, Ramakrishna, Brieger et al. 1989, Okolo, Adewunmi et al. 1999, Ofovwe, Ibadin et al. 2002). While the division of the country into geopolitical zones is based on geographical boundaries, there are similarities between states within the same geopolitical zone and differences between states across different geopolitical zones. Several studies have reported differences in mortality rates across geopolitical zones (Aigbe and Zannu 2012, Adeyele 2013). Another study reported that both infant and child mortality was significantly associated with zone of residence in Nigeria with the risk of infant mortality significantly higher for mothers in north-east and north-west regions of Nigeria after adjusting for wealth and mothers' education compared with mothers in south-west and north-central regions of Nigeria (Anyamele, Akanegbu et al. 2015). Risks of under-five deaths were reported to be significantly higher for children of mothers residing in the south-south zone (Antai 2011) and in another study the prevalence of under-five death was highest among children of Hausa/Fulani/Kanuri mothers and lowest among children of Yoruba mothers (Antai 2011).

Demographic and Health Survey (DHS) data represents reliable source for identifying the risk factors of childhood. The representative nature of DHS data offers a great advantage in identifying the socio-economic factors associated with under-five mortality. It is therefore important to explore the latest Nigeria Demographic and Health Survey (NDHS) data to identify the determinants responsible for under-five mortality in Nigeria. This paper describes the socio-economic and other risk factors associated with under-five mortality in Nigeria. Results from the study provide additional information that could be useful in planning intervention programs for

childhood survival in Nigeria and other low-income countries with similar characteristics.

METHODS

Setting

Nigeria, officially the Federal republic of Nigeria, is a federal constitutional republic comprising 36 states and its Federal Capital Territory (FCT), Abuja. It is grouped into six geo-political zones/regions: North West, North East, North Central, South East, South West and South- South. Nigeria has a total area of 923,768 km^2 (356,669 sq. mi), making it the world's 32nd-largest country and its highest point is Chappal Waddi at 2,419 m (7,936 ft.) (CIA 1999). With a 2013 estimated population of approximately 173 million inhabitants, Nigeria is the most populous country in Africa and the seventh most populous country in the world (World Bank 2015b). The United Nations estimates that the population in 2009 was at 154,729,000, distributed as 51.7% rural and 48.3% urban, and with a population density of 167.5 people per square kilometer (Babalola 2012). National census results in the past few decades have been disputed because census figures are used to determine regional funding and representation of ethnic and religious groups in government service. This provides an incentive for inflating local populations. Census figures are believed to have been manipulated in the past for political advantage (Bamgbose 2009). The results of the most recent census were released in December 2006 and gave a population of 140,003,542 with 71,709,859 males (51%) and 68,293,683 females (49%) (NPC Nigeria 2007). 48% of this population reside in the southern zones. The country is inhabited by over 500 ethnic groups, of which the three largest are the Hausa, Yoruba and Igbo. According to 2013 NDHS (Demographic 2013)

children under -five accounted for 17% of the Nigeria population which makes every unit change in mortality to reflect great effect in the population. The health indices are characterized by wide regional disparities and generally better in the southern than the northern zones (Demographic 2013). In April 2014, following a rebasing exercise, Nigeria's economy (GDP) became the largest in Africa, worth more than $500 billion, and overtook South Africa to become the world's 21st largest economy (Magnowski 2014).

Study design

This is a secondary analysis of population-based cross-sectional study which examined the effect of socio-economic and other factors on under-five mortality in Nigeria using the 2013 National Demographic and Health Survey data.

Sampling technique

Detail information about the sampling technique that was applied for the data collection had been published in the final report of 2013 NDHS (Demographic 2013). However, it suffices to state that the NDHS was set to yield a nationally representative sample of women aged 15-49 years and men aged 15-59 years. The sampling frame used was provided by the National Population Commission, based on the 2006 national census. A stratified three-stage cluster design consisting of 904 clusters, 372 in the urban and 532 in the rural areas was used to select the sample. They were allocated among the 36 states and FCT based on their size and rural/urban areas. Sample frame of households in each selected cluster was obtained and these households were randomly sampled from. At the end of the sampling procedure, a representative sample of 40,680 households was selected. 39,902 women aged 15 – 49

and 18,229 men aged 15 – 59 in these households across the 36 states and the FCT were interviewed. Response rate was 99% and there was no significant difference between rural and urban areas in terms of response rates.

Data collection

Detail information about the data collection and questionnaires has been published in the final report of 2013 NDHS (Demographic 2013). Three types of standardized questionnaires (household, women's and men's questionnaires) were used and face-to-face interviews were conducted. Information was obtained about the children and their mothers and household. The topics of the questions asked for the women include: background characteristics (age, religion, education, literacy, media exposure etc.), reproductive history and childhood mortality, knowledge, source, and use of family planning methods, fertility preferences, antenatal, delivery, and postnatal care, breastfeeding and infant feeding practices, child immunization and childhood illnesses, marriage and sexual activity, women's work and husbands' background characteristics, malaria prevention and treatment, women's decision making, awareness of AIDS and other sexually transmitted infections, maternal mortality, domestic violence. A key component of the data collection is the maternity history where women were asked about their birth histories with data on date of birth, sex of the child, current age, age at death (for dead children), and relevant background characteristics. Fieldwork started in February 2013 and ended in June 2013. With regards to quality, training for fieldworkers was for 4 weeks. Field team constituted of 1 supervisor, 1 field editor, 4 female interviewers, and 2 male interviewers. The survey used quality controllers made up of the technical team and trainers and also monitored quality using field check tables that were generated concurrently with data

processing operations. The surveys was also monitored by external bodies. Specifically, the quality controllers made sure that that the correct numbers of questionnaires and eligible respondents were used, checked that all questionnaires were entered and ensured that all questionnaires were entered twice, verified by comparing both data sets and all discrepancies were resolved. CSPro computer package for data processing.

Study variables

The main outcome variable is the risk of under-five mortality. Under-five mortality was defined as the probability of dying before completing the fifth birthday. Selection of independent variables was based on previous studies [10-31, 36-48]. The independent variables were geopolitical zones, area of residence (urban/rural), household income, household size and maternal education (See Table 2).

Table 3: Definition of Variables in regression model

Variable	Variable type	Definition
Under-five Mortality	Binary (Alive: Dead)	Child dead before fifth birthday (59 months)
Geopolitical zone	Categorical	Geopolitical zones of Nigeria (North Central, North East, North West, South East, South South, South West)
Area of Residence	Categorical	Household within an urban/rural setting
Household Income	Ordered Categorical	Wealth quintile based on household item list (Poorest, Poorer, Middle, Richer, Richest)
Household Size	Continuous	Number of members of household
Mothers Education	Ordered Categorical	Level of education completed (None, Primary, Secondary, Higher)

Data analysis

Using STATA version 13, the relationship between the dependent (outcome) variable and the independent variables was analyzed. Recoding and renaming were done for

both independent and dependent variables. One survival dependent variable was generated. Descriptive analysis of the variables was done. Univariate logistic regression was used to examine the association between the independent variables and the dependent outcome. Only independent variables that were statistically significant (P-value = 0.05) were incorporated into multivariate logistic regression. Likelihood Ratio test (LHR test) was used to test for the goodness of fit of the model. Hosmer-Lemeshow goodness-of-fit was used to examine the fitness of the model. Variance Inflation Factor (VIF) was used to check for multicollinearity. Predictive and complexity characteristics of the model were considered during modelling. Effects of covariates were expressed as Odds Ratio with their 95% Confidence Interval (CI).

Ethical considerations

Permission to use the data was obtained from ORC Macro International, the agency responsible for the worldwide Demographic and Health Surveys.

RESULTS

Background characteristics

This survey retrospectively covered from the year 2008 to 2013. Out of all the 31,482 live births recorded in the 2013 NDHS, there were 2886 (9%) recorded deaths among children aged zero to five years. The highest proportion of live births was from the North West zone (32%) while the lowest proportion of live birth was from the South East zone (9%). About two-thirds (67%) were in the rural areas and approximately half of the children were born to mothers with no formal education (47%) while 20% and 33% were born to mothers with primary and secondary or higher educational attainment respectively. Furthermore, average number of family members is 7 and

about 46% of the children were from poor households. These results are shown in Table 3.

Table 4: Distribution of live births according to selected background characteristics, Nigeria, 2013

	Frequency (N=31,482)	Percentage
Under-five mortality		
Alive	28596	90.8
Dead	2886	9.2
Geopolitical zone		
North Central	4614	14.7
North East	6517	20.7
North West	9906	31.5
South East	2816	8.9
South South	3747	11.9
South West	3882	12.3
Area of Residence		
Urban	10351	32.9
Rural	21131	67.1
Maternal Education		
No education	14762	46.9
Primary	6432	20.4
Secondary	8365	26.6
Higher	1923	6.1
Household Income (Wealth Index)		
Poorest	7076	22.5
Poorer	7386	23.5
Middle	6272	19.9
Richer	5806	18.4
Richest	4942	15.7
Household size Mean(SD)	7(4)	

Distribution of Under-five mortality by background characteristics

Across the highest proportion of under-five mortality was in the North West zone with 12.% of children dying before their fifth birthday while the lowest mortality was in the South West zone (6%). Under-five mortality was recorded 1.6 times more in the rural than urban areas. Proportion of under-five mortality was 11% among children born to women with no formal education and 5% among those born to women with

higher than secondary education. Proportion of under-five death was 12% in both the poorest and poorer wealth quintiles and 5% in the richest quintile. These results are shown in Table 4.

Table 5 Distribution of under-five mortality by background characteristics, Nigeria, 2013

	Frequency (Number dead before 5th birthday)	Percentage
Geopolitical zone		
North Central	328	7.1
North East	661	10.1
North West	1146	11.6
South East	263	9.3
South South	249	6.6
South West	239	6.2
Area of Residence		
Urban	666	6.4
Rural	2220	10.5
Maternal Education		
No education	1657	11.2
Primary	596	9.3
Secondary	547	6.5
Higher	86	4.5
Household Income (Wealth Index)		
Poorest	835	11.8
Poorer	887	12.0
Middle	502	8.0
Richer	412	7.1
Richest	250	5.1

Univariate analyses

The results of univariate (unadjusted) analyses are shown in Table 5. Odds of under-five mortality was reduced by 50% in South West compared to the North West. It was also reduced across all zones compared to the North West (14% in the North East, 21% in the South East, 41% in the North central and 46% in the South South). When

compared to urban areas, odds of under-five mortality was increased by 71% in rural areas.

Table 6: Results of univariate analysis: Logistic regression of under-five mortality

Explanatory Variables	Odds Ratio (OR)	P-value	95% Confidence Interval
Geopolitical zone			
North West (Ref)	1.00		
North Central	0.59	0.004	0.52 – 0.67
North East	0.86	0.001	0.78 – 0.96
South East	0.79	0.000	0.68 – 0.91
South South	0.54	0.000	0.47 – 0.63
South West	0.50	0.000	0.43 – 0.58
Area of Residence			
Urban (Ref)	1.00		
Rural	1.71	0.000	1.56 – 1.87
Maternal Education			
No education (Ref)	1.00		
Primary	0.81	0.000	0.73 – 0.89
Secondary	0.55	0.000	0.50 – 0.61
Higher	0.37	0.000	0.30 – 0.46
Household Income (Wealth Index)			
Poorest (Ref)	1.00		
Poorer	1.02	0.698	0.92 – 1.13
Middle	0.65	0.000	0.58 – 0.73
Richer	0.57	0.000	0.51 – 0.65
Richest	0.40	0.000	0.34 – 0.46
Household Size			
Household size	0.95	0.000	0.94 – 0.96

Among the children of mothers that have primary, secondary and higher education, odds of under-five mortality was reduced by 19%, 45% and 63% respectively compared to children of mothers with no education. These were all significant.

Before adjusting for other factors, the likelihood of under-five mortality in children from richest quintile was reduced by 60% compared to children from households in the poorest quintile. There was no statistically significant difference between the odds of under-five mortality among children from households in the poorest quintile and

those in households from the poorer quintile. Household size was inversely related to the odds of child mortality. With each unit increase in household members, the odds of child mortality reduced by 5%.

Multivariate analyses

The results of multivariable analyses, where all factors were controlled for are shown in Table 6.

Table 7: Results of multivariate analysis: Logistic regression of under-five mortality

Explanatory Variables	Odds Ratio (OR)	P-value	95% Confidence Interval
Geopolitical zone			
North West (Ref)	1.00		
North Central	0.69	0.000	0.60 – 0.79
North East	0.90	0.048	0.81 – 1.00
South East	1.15	0.111	0.97 – 1.35
South South	0.71	0.000	0.60 – 0.84
South West	0.72	0.000	0.61 – 0.85
Area of Residence			
Urban (Ref)	1.00		
Rural	1.28	0.000	1.14 – 1.43
Maternal Education			
No education (Ref)	1.00		
Primary	0.96	0.504	0.86 – 1.08
Secondary	0.70	0.000	0.61 – 0.81
Higher	0.56	0.000	0.43 – 0.73
Household Income (Wealth Index)			
Poorest (Ref)	1.00		
Poorer	1.07	0.200	0.97 – 1.19
Middle	0.81	0.002	0.71 – 0.92
Richer	0.82	0.013	0.70 – 0.96
Richest	0.69	0.000	0.56 – 0.85
Household Size			
Household size	0.92	0.000	0.91 – 0.93

Effect of area of residence remained statistically significant. The likelihood of under-five mortality among children in rural areas was increased by 28% compared to children in urban areas. Having controlled for all factors, under-five mortality in the

different geopolitical zones varied. There was no statistically significant difference between the odds of under-five mortality among children living in the South East when compared to those living in the North West when other confounders have been considered. However, odds of under-five mortality reduced by 10%, 28%, 29% and 31% in the North East, South West, South South and North Central respectively when compared to the North West.

Similarly, there was no statistically significant difference between the odds of under-five mortality for children from households in the poorer quintile compared to those from households in the poorest quintile. However, the odds of under-five mortality was reduced by 19%, 18% and 31% among children from households in the middle, richer and richest wealth quintile respectively when compared to children from the poorest wealth quintile.

Having controlled for other factors, there was no statistically significant difference between the odds of under-five mortality among children of mothers with only primary education compared to those whose mothers had no formal education. Odds of under-five mortality was significantly reduced for increased educational level with mothers with secondary education reducing the odds by 30%. Children whose mothers had higher than secondary education had theirs odds of under-five mortality reduced by 44%. Despite the adjustment for confounders the independent effect of household size remained significant. Tthe likelihood of under-five mortality was reduced by 8% with each unit increase in household members.

Model fit and Predictive power of the models

Likelihood ratio test (LHR test) and Hosmer-Lemeshow goodness-of-fit were used to examine the fitness of the model. None of these raise any question concerning the fitness of the models. Variance inflation factor (VIF) was employed to check for multicollinearity. None of the VIF values were up to 10 and the mean VIF of the model was less than 5. It means there was no collinearity in the model.

DISCUSSION

The results of this study provides more insight on risk factors of under-five mortality in Nigeria. In this paper, we described the effect of socio-economic and other factors on under-five mortality in Nigeria using the 2013 Nigeria Demographic and Health Survey. Disparities exist child survival between the geopolitical zones in the country. With the exception of the South East, survival of children living in any other zone of Nigeria was better than those residing in North West. Children in North West of Nigeria were 69% more likely to die before their 5th year birthday than their counterparts in North Central zone of Nigeria. Previous studies have also reported zonal differences in under-five mortality (Aigbe and Zannu 2012, Kayode, Adekanmbi et al. 2012, Adeyele 2013, Anyamele, Akanegbu et al. 2015). This is possibly due to the differences in the cultural practices across the different communities that make up geo-political zones. These cultural practices affect health seeking behavior and would impact child mortality. Some these studies have also attributed this differences to variations in vegetation across the geopolitical zones stating that children tend to survive better in regions with better agricultural output than regions with low output (Kayode, Adekanmbi et al. 2012).

This study has also shown that area of residence was a strong predictor for under-five mortality. Children raised in urban areas were more likely to survive better than those in rural areas. This is in accordance with the findings of other studies (Akoto and Tambashe 2002, Fotso and Kuate-Defo 2005, Smith, Ruel et al. 2005, Kayode, Adekanmbi et al. 2012). This may be attributed to the increased availability of public infrastructure that provides sanitation services, including water supply, household waste and excreta removal and disinfection, as well as health care infrastructure. It is important to note that urban population in Nigeria increased from 36.3% in 2008 to 42.7% in 2013 and this growth is expected to continue (Fotso 2007). It is also perceived that the rate of growth of the urban population is will be faster than the growth of the economy (Fotso 2007). This will most likely affect the provision of adequate infrastructure to support the urbanization. Situations like this lead to overcrowded slums and shantytowns existing amidst contaminated and harmful environment hence increasing the risk of various health problems and epidemics in urban areas (Zulu, Dodoo et al. 2002).

The influence of maternal education on under-five mortality was supported by the results of this study. While it showed no difference between no formal education and primary education, it also showed a huge reduction in the odds of under-five mortality by secondary and higher than secondary education. This findings supports several studies that link mother's educational attainment with child mortality (Buor 2003, Basu and Stephenson 2005, Cleland and van Ginneken 2008, Cleland 2010, Gakidou, Cowling et al. 2010). Mother's education affects child health through a variety of ways; majorly mother's education affects her knowledge, attitude and practices towards child health positively. Educated mothers take better decisions and higher

purchasing power on utilization of health care services; both preventive and curative health services. Educated mothers also tend to have lower risk for other maternal factors that are associated with child mortality, for example, maternal age at first marriage, use of contraception, birth interval and female decision making (Kayode, Adekanmbi et al. 2012).

This study also found that household income was a strong predictor of child mortality. The odds of under-five mortality was reduced by as much as 31% for children from households in the richest wealth quintile compared to those from households in the poorest wealth quintile. This is line with other studies (Ecob and Smith 1999, Wagstaff and Van Doorslaer 2000). This has been explained as being due to the ability of the household to purchase basic needs like food, water and shelter. It has also been attributed to the ability of the household to access and purchase healthcare. This is particularly important in Nigeria as healthcare expenditure in Nigeria is majorly from out of pocket spending (Onwujekwe, Uzochukwu et al. 2010) thus making households susceptible to catastrophic health spending.

It is essential to report that this study yielded a skewed results although it can be explained. Prior studies have increasing household size to increasing child mortality (Jolly and Gribble 1993, Adegboyega, Ntozi et al. 1997). However, this study findings supports that increasing household size reduces the odds of under-five mortality in Nigeria. This positive relationship has also been found in another study (Charmarbagwala, Ranger et al. 2004). This positive relationship can be due to a higher earning/production effect leading to a lower dependency ratio (that is the ratio of non-working to working household members). More likely, particularly in the Nigerian setting, this might be attributed to the availability of additional child carers,

such as grandparents or older children. This correlation could also be due to the direct relationship between child mortality and household size given that households with high mortality will have lower household size than households with low mortality.

It is important to discuss the strengths and limitations of this study. This study is based on nationally representative data collected via a consistent methodology thus reflects the true studied population, Nigeria. Its findings can also generalized to any other country's population similar to Nigeria. In addition, it provides a deep dive into the 2013 NDHS and as such could serve as benchmark and stimulus for further nationwide studies on this same subject particularly exploring the differences between geopolitical zones in Nigeria. With regards to limitations, while this study is important in describing which contextual factors are associated with lower risk of child mortality, it does not quantify the contribution of each factor. As with all data on birth history, they are subject to recall bias though evidence exist that this will only bias mortality rate by 5 – 7% (Curtis 1995, Byass, Worku et al. 2007). It is also important to note that these types of studies cannot measure causal effect but can only measure associations.

CONCLUSION

This study has revealed that socioeconomic and other factors were the important determinants of under-five mortality in Nigeria. These findings are similar to those reported for other developing countries. As the country gears towards a push to reduce under-five mortality, these factors should be properly considered during planning, formulation and implementation of national strategic development plan. Education of the girl child beyond primary school level could play a vital role in this drive to improve child survival.

PAPER 2: Using LiST to understand the significant interventions in reduction of under-five mortality in Nigeria: national and sub-national analysis

ABSTRACT:

Background: Although under-five mortality rate is reducing in Nigeria, mortality of children under five years of age remains high. The country was not able to meet Millennium Development Goal 4 (MDG4). This is despite policies, programs and interventions aimed at addressing maternal, newborn, and child health being implemented in the country. Disparities abound within the geopolitical zones and the individual states in the country with the northern zones and states faring worse off than southern zones and states in terms of both health outcomes and coverage of health interventions. Determining the interventions driving the decline in child mortality will go a long in informing the country as it drives towards the Sustainable Development Goals (SDGs).

Methods: A secondary analysis of population-based cross-sectional surveys using the Lives Saved Tool (LiST) was done to determine the additional lives of children less than five years of age saved between 2008 and 2013 based on changes in coverage of health interventions. Data were obtained from the Demographic and Health Surveys 2008 and 2013, the Malaria Indicator Survey 2010 and the Multiple Indicator Cluster Survey 2011. In addition to the national model, subnational models were created for the six geo-political zones in Nigeria to examine the differences in coverage of health interventions and health outcomes across the zones. The additional lives saved by each intervention were summed together for similar interventions.

Results: With the exception of malaria prevention interventions, care seeking for pneumonia and Vitamin A supplementation, there was a less than 10 percentage points difference in coverage of maternal and child health interventions in Nigeria between 2008 and 2013. The most improved coverage of health interventions was Vitamin A supplementation which increased from zero percent coverage to 70 percent coverage in 2013. Malaria prevention interventions improved with the percent of households owning at least one insecticide treated net or protected by indoor residual spraying increasing from 8 in 2008 to 50.1 in 2013. Haemophilus influenza type B (Hib) vaccine was introduced in the country in 2012 achieving a coverage rate of 30 percent in 2013 while the coverage of DPT3 and Measles vaccine has gradually declined. A total of 370,000 additional lives of children less than five years of age were saved between 2008 and 2013 with 50 percent attributable to household protection from malaria and 25 percent attributable to Vitamin A supplementation. Across the geo-political zones, 61 percent of the additional lives saved were from the North-East and North-West zones.

Conclusion: These findings suggest that while progress has been made to some extent, significant improvements need to be made to drive the uptake of health interventions in the country in order to achieve the SDGs. Of importance is the decline in uptake of Water, Sanitation and Hygiene interventions. These efforts need to specific to the geo-political zones in the country as wide variations exist in the coverage of health interventions across zones. Understanding the drivers of uptake of health interventions will help push this effort while maintain current efforts to sustain the gains from malaria prevention and Vitamin A supplementation in Nigeria.

INTRODUCTION

Child mortality is an important measure of health and development of any society and Nigeria remains a country with high mortality for children under five years of age. Reduction of Under-five mortality rate (U5MR), was a Millennium Development Goal (MDG) indicator. The aim of the UN Millennium Development Goal 4 (MDG4) was to reduce mortality in children younger than 5 years by two-thirds between 1990 and 2015 (UN General Assembly 2000). The MDG ran from 2000 – 2015 and Nigeria did not meets its MDG4 target (Oleribe and Taylor-Robinson 2016). With an U5MR of 129 deaths per 1,000 live births (Demographic 2013), Nigeria (13%) along with India (21%) account for more than one-third of all deaths among children below 5 years of age (WHO 2015c). Out of the 47 countries the WHO African region, Nigeria's U5MR is only better than 7 countries (WHO 2015e). Results from the 2013 Nigeria Demographic and Health Survey (NDHS) confirm that under-five mortality has been declining from 157 in 2008 to 128 deaths per 1,000 livebirths in 2013 (Demographic 2013), however these reductions in mortality were not enough for Nigeria to meet the MDG4 target.

Globally while the most common cause of under-five death in 2013 were from neonatal causes (44 percent), malaria, pneumonia, and diarrhea were also important contributors accounting for 7, 15, and 9 percent respectively (Liu, Oza et al. 2015). The impact of these diseases in Nigeria were more significant with malaria, pneumonia and diarrhea accounting for 31, 19, and 14 percent of under-five mortality respectively (WHO 2014). Figure 13 shows the distribution of under-five deaths in Nigeria by cause in 2013 (WHO 2014).

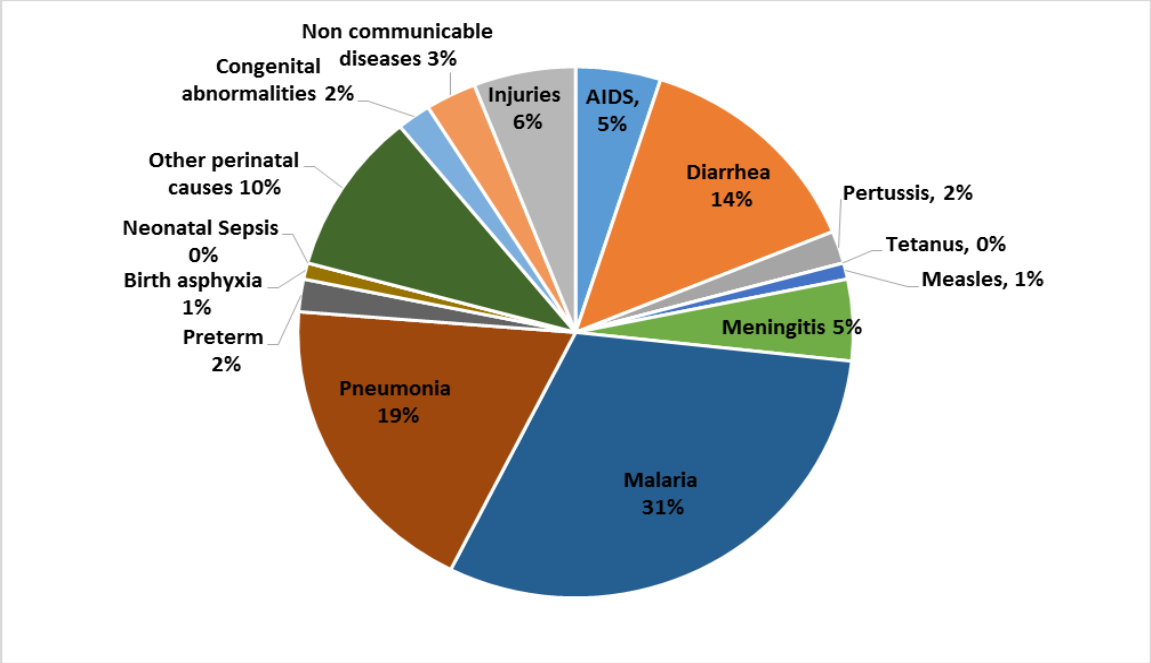


Figure 13: Causes of Under-five deaths in Nigeria in 2013

Achieving the goal for reducing U5MR require universal coverage of key health interventions e.g. care for newborns, infant and young child feeding; vaccines; management of pneumonia and diarrhea; malaria control etc. In countries with high mortality, these interventions could reduce the number of under-five deaths by more than half (WHO 2015b).

Nigeria is divided administratively into thirty-six states and one Federal Capital Territory (FCT) that are further sub-divided into 774 Local Government Areas (LGAs). Each of these three levels of government (Federal, State and Local) all have concurrent constitutional and fiscal responsibility regarding health (Akhtar 1991). Politically, these states and the FCT are grouped into six geopolitical zones based on geographical proximity: North-Central, North-East, North-West, South-East, South-South, and South-West zones. This is particularly important because disparities within these geopolitical zones and the individual states are stark with the northern

zones and states faring poorer than southern zones and states in terms of both health outcomes and coverage of health interventions as can be seen in the 2013 NDHS. For example, U5MR in the North-West zone is 185 per 1,000 live births while it is 90 per 1,000 live births in the South-West zone, and in terms of health intervention coverage, in the North-West zone only 10% of children in the age group of 12-23 months are fully vaccinated, as compared to almost 41% in the South-West zone (Demographic 2013). See Figure 14. Again total fertility rates vary across the geo-political zones as follows;

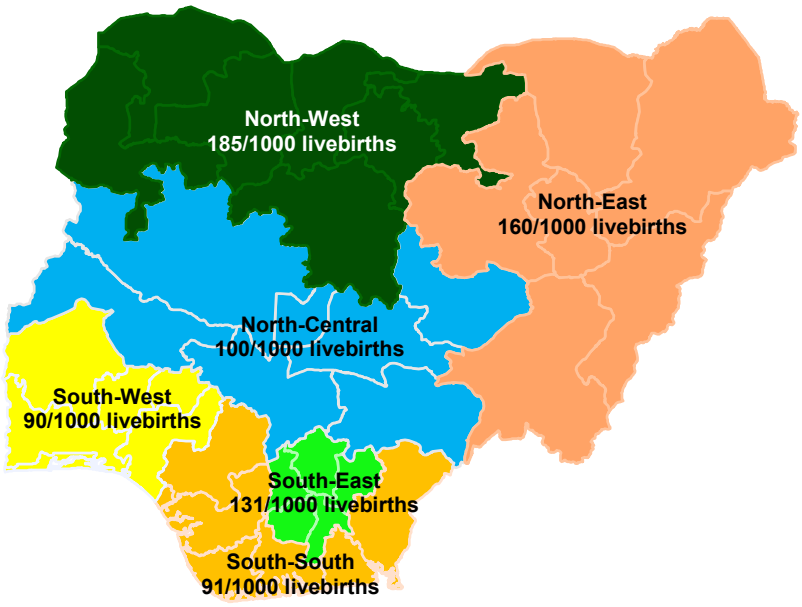


Figure 14: U5MR by Geo-political zones of Nigeria

North-West – 6.7, North-East – 6.3, North-Central – 5.3, South-East – 4.7, South-West – 4.6 and South-South – 4.3. These impact delivery of maternal and child health services.

The Nigerian government has made efforts to combat the causes of deaths of children less than five years of age. An example is the National child health policy of 2006 (Federal Ministry of Health Nigeria 2006) which sets forth priorities, strategies and interventions necessary to address some of the challenges of child health care such as measles, diarrhea, acute respiratory infections, malnutrition, low birth weight,

asphyxia, sepsis, neonatal jaundice and neonatal tetanus, malaria and helminthic infections like ascariasis and schistosomiasis. In terms of implementation of interventions, Nigeria has set up several agencies and programs to implement these policies.

The National Primary Health Care Development Agency (NPHCDA) was established in 1992 with the mandate to develop national primary health care (PHC) policies and to support states and LGAs to implement them. It has state arms in about 21 states of the federation and implements most health programs targeting mothers and children at the primary health care level. Programs carried out by the NPHCDA include the Maternal, Newborn and Child Health weeks (MNCH weeks) where immunizations are given to missed opportunity children as well other health interventions like family planning, ORS, child nutrition intervention like identifying and managing malnourished children, Vitamin A supplementation and deworming are given out as well as identifying and treating of children with respiratory tract infections. These programs are usually facility based with occasional community outreaches. They are also mostly designed at the federal level and cascaded down to the PHC centers that operate at the local government level.

The National Malaria Control Program was established in 2001 and became the National Malaria Elimination Program (NMEP) in 2013 (Muanya 2013) with a specific aim of tackling malaria by prevention through distribution of long lasting insecticide treated nets, diagnosis using rapid diagnostic test kits and treatment with Artemisinin based Combination Therapy (ACT). These programs are also designed at

the federal level and implemented at the facility level with limited contextual input from the local government.

In addition to these agencies and programs, the government had also tried to accelerate Nigeria's progress towards the MDG 4 with some unique initiatives that specifically target mothers and children. Some of these are Midwives Service Scheme (MSS), a program which aims to increase the availability of skilled birth attendants in underserved regions of the country; the SURE-P MNCH which while improving human resources for health also improves demand for health care through innovations like conditional cash transfers (CCT) to boost demand for MNCH services; and the Saving One Million Lives Initiative (SOML) which was launched in 2012 with a goal of driving and accentuating the efforts of the Federal Ministry of Health towards saving an additional one million lives of children under five years and women of child bearing age by 2015.

Given that U5MR in Nigeria while decreasing did not meet the MDG 4 target, it becomes pertinent to identify the interventions significant in contributing in the decline to enable the country accelerate this rate of decline. Furthermore, while geo-political zones are for administrative and demographic purposes – health intervention programs are not designed by zones, it is important to study the difference between the different geo-political zones in Nigeria and how they contribute to the declining U5MR. This might provide the evidence for acknowledging contextual differences in designing health interventions.

This paper looks to provide information on the interventions that contributed the most lives saved for children under five years of age thereby reducing under-five mortality

in Nigeria. It also investigates this at the subnational levels of geo-political zones. This will provide the much needed evidence base required by the country to accelerate the decline of U5MR.

This paper uses the Lives Saved Tool (LiST) to model the impact of the changes in the coverage of the various health intervention targeting children less than five years on the mortality of this age group. The Lives Saved Tool is a multi-cause model of mortality that maybe used to predict changes in Under-five and neonatal mortality rates and deaths, maternal mortality ratios and deaths, stillbirth rates and deaths, causes of death using country specific health status, changes in child and maternal health intervention coverage levels i.e. ORS, facility delivery, etc. and effect sizes of interventions based on the best available evidence (Walker and Walker 2014). It operates within the Spectrum software. While *LiST* is mainly used to estimate the impact of scaling up interventions on mortality to provide evidence for the potential effectiveness of an intervention, to help in refocusing priorities, or to set targets at a global level as well as to guide the strategic planning process especially in developing countries, it can also be used to show projected reduction in mortality from measured change in coverage of health interventions (Walker, Tam et al. 2013). It can also calculate the number of additional lives saved or lost by changes in coverage of interventions. Groups have used the LiST to retrospectively attribute the causes of measured or observed declines in mortality to specific activities (Afnan-Holmes, Magoma et al. 2015). Several studies have validated the estimates of LiST in the past. LiST was used in a case study in Niger to assess the contribution of different interventions to observed reductions in child mortality (Amouzou, Habi et al. 2012). Another study compared the mortality rate measured by an evaluation study with the

mortality rate modelled by LiST in Ghana and Mali and found that the estimated mortality reduction in Ghana was within the 95% confidence boundaries of the measured reduction while the modelled reduction in Mali underestimated the reduction (Hazel, Gilroy et al. 2010). Generally, mortality reductions estimated by LiST have performed well when compared against measured data following the scale-up of packages of child survival interventions in various settings (Amouzou, Richard et al. 2010, Friberg, Bhutta et al. 2010, Hazel, Gilroy et al. 2010, Amouzou, Habi et al. 2012).

METHODS

Study design

This is a secondary analysis of population-based cross-sectional surveys (NDHS 2008, MIS 2010, MICS 2011 and NDHS 2013) using the Lives Saved Tool (LiST) to determine the health interventions that contributed the most lives saved for children under 5 years of age thereby reducing U5MR. This analysis is done at both the national and subnational levels of geo-political zones.

Setting

This is study in set in Nigeria, officially the Federal republic of Nigeria. With a 2013 estimated population of approximately 173 million inhabitants, Nigeria is the most populous country in Africa and the seventh most populous country in the world (World Bank 2015b). According to the most recent population censes, the population is spread out across the six geo-political zones as follows; North-West (26%), North-East (14%), North-Central (14%), South-East (12%), South-West (20%) and South-South (15%)

(NPC Nigeria 2007). United Nations estimates that the population in 2009 was at 154,729,000, distributed as 51.7% rural and 48.3% urban, and with a population density of 167.5 people per square kilometer (Babalola 2012). National census results in the past few decades have been disputed because census figures are used to determine regional funding and representation of ethnic and religious groups in government service. This provides an incentive for inflating local populations. Census figures are believed to have been manipulated in the past for political advantage (Bamgbose 2009). According to 2013 NDHS (Demographic 2013) children under -five accounted for 17% of the Nigeria population which makes every unit change in mortality to reflect great effect in the population. The health indices are characterized by wide regional disparities and are generally better in the southern than the northern zones (Demographic 2013).

Lives Saved Tool (LiST)

The Lives Saved Tool uses country-specific demographic and epidemiologic data to predict the effect of changes in coverage of health interventions on mortality rates of children and mothers. It allows the user to identify the magnitude of effect of specific health interventions on health outcomes. The evidence for LiST comes from the technical expertise of the Child Health Epidemiology Reference Group (CHERG) for estimation of key inputs, such as cause-specific mortality by country and intervention effectiveness (Boschi-Pinto, Young et al. 2010). A description of the role of CHERG in the development of LiST is available elsewhere (Boschi-Pinto, Bahl et al. 2009). Supporting documentation for the interventions included in LiST is referenced within

the software and available in a series of LiST journal supplements (Boschi-Pinto, Bahl et al. 2009, Fox, Marterell et al. 2011).

The tool is built on the broad concept that based on; 1) the population of a particular country (factoring in population growth), 2) the given health status of the country and mortality rate hence the number of deaths in the country, 3) the causes of mortality specific to the country, changes in the population coverage of certain interventions based on their effectiveness will avert an estimated number of death thereby reducing mortality. The LiST has been described as a linear mathematical model that is deterministic with a fixed relationship between inputs and outputs, leading to the same outputs each time the model is run with identical inputs (Garnett, Cousens et al. 2011). The inputs are usually coverage of interventions (baseline and target) and the outputs are changes in population-level risk factors (e.g., wasting or stunting rates) or cause-specific mortality and age-specific mortality (e.g., Under-five mortality). A grand assumption is implied in LiST estimates and that is that mortality rates and cause of death structures in a country will not change dynamically and that the difference between the baseline year and the endline year is a response to changes in intervention coverage (Walker and Walker 2014). Another assumption is that distal variables like increases in per capita income or higher levels of maternal education cause changes in mortality through the effects of changes in coverage of interventions or by reducing risk factors other risk factors.

LiST works by attributing lives saved/deaths averted to changes in coverage of specific interventions and risk factors based on the effectiveness of these interventions. It works by attributing impact sequentially along the continuum of care from peri-

conceptual through delivery and within specific age groups. It does this first for preventive interventions then curative interventions with regards to multiple interventions that affect the same cause of death. This means that if both preventive and curative interventions for a particular cause of death are scaled up at the same time, the LiST first calculates the full effect of the preventive interventions and attributes it to the preventive interventions then any residual death averted are calculated and attributed to curative interventions based on their effectiveness (Walker, Tam et al. 2013). To attribute deaths averted by specific interventions within the same category (preventive interventions) that affect the same cause of death, the LiST makes an additional calculation. It calculates a proportional impact of the interventions which is calculated as increase in coverage times the effectiveness of the intervention. This proportional impact is then applied to the total deaths averted by preventive interventions. The same approach is used for multiple curative interventions (Walker, Tam et al. 2013).

Data sources

LiST requires the coverage trend of an intervention to project the effect of changes in coverage on the health outcome of interest. Coverage of health intervention is measured as the proportion of those needing an intervention who receive it. For this study coverage level of the various interventions were obtained from different data sources:

NDHS 2008 and NDHS 2013

The 2008 Nigerian Demographic and Health Survey (NDHS) (Macro and Commission 2009), was implemented in 2008 with fieldwork taking place from June to October 2008 on a nationally representative sample of 36800 households. The sampling frame used for the 2008 NDHS was the 2006 population and housing census of Nigeria conducted in 2006. The sample was selected using a stratified two-stage cluster design consisting of 888 clusters, 286 in the urban and 602 in the rural areas. The second stage of selection was done using equal probability systemic sampling. The survey interviewed 33,385 women aged 15 – 49 and 15,486 men aged 15 – 59 in these households across the 36 states and federal capital territory of Nigeria. The response rate for the 2008 NDHS was 98% and there was no significant difference between rural and urban areas in terms of response rates (Macro and Commission 2009).

The 2013 NDHS was implemented in 2013 with fieldwork taking place between February and June 2013. The sampling frame used for the 2013 NDHS was also the 2006 population and housing census of Nigeria conducted in 2006, however, a stratified three-stage cluster design was consisting of 904 clusters, 372 in the urban and 532 in the rural areas was used to select the sample. A representative sample of 40,680 households was selected and the survey interviewed 39,902 women aged 15 – 49 and 18,229 men aged 15 – 59 in these households across the 36 states and federal capital territory of Nigeria. The response rate for the 2013 NDHS was 99% and there was no significant difference between rural and urban areas in terms of response rates (Demographic 2013).

To ensure the quality of both surveys, training for fieldworkers was for 3 weeks in 2008 and 4 weeks in 2013. Team constituted of 1 supervisor, 1 field editor, 4 female interviewers, and 2 male interviewers for both surveys. The 2008 survey assured quality in the field by using quality control interviewers while the 2013 survey used quality controllers made up of the technical team and trainers. The 2013 also monitored quality using field check tables that were generated concurrently with data processing operations. Both surveys were monitored by external bodies. Specifically, the quality controllers made sure that that the correct numbers of questionnaires and eligible respondents were used, checked that all questionnaires were entered and ensured that all questionnaires were entered twice, verified by comparing both data sets and all discrepancies were resolved. Both surveys used the CSPro computer package for data processing.

MIS 2010 and MICS 2011

The 2010 Nigeria Malaria Indicator Survey (MIS) (Commission 2012) is a nationally representative cross-sectional survey that measured progress towards the goals of the 2009 – 2013 National Strategic Plan for Malaria Control in Nigeria. The MIS had a representative sample of 6,000 households and interviewed a total of 6,344 women aged 15 – 49 years and had a response rate of 97%. Aside from the questionnaires, the survey also tested for anemia and malaria among children 6-59 months using finger/heel prick blood samples. The sampling frame used for the 2010 MIS was also the 2006 population and housing census of Nigeria conducted in 2006. The sample was selected using a stratified, two-stage cluster design consisting of 240 clusters, 83 in the urban areas and 157 in the rural areas. The 2010 MIS was implemented in

2010 with fieldwork taking place between October and December 2010. To ensure the quality of both surveys, training for fieldworkers was for 2 weeks. Team constituted of 1 supervisor/editor, 2 female interviewers, 1 nurse/interviewer and 1 laboratory scientist. Each geo-political zone had a quality control interviewer who re-administered the questionnaires in approximately 10% of all completed households. Data entry was done using the CSPro software and all questionnaires were entered twice.

The 2011 Multiple Indicator Cluster Survey (MICS) (NBS and UNICEF 2013) is a nationally representative cross-sectional survey that monitored progress towards the Millennium declaration. The MICS had a representative sample of 29,349 households and interviewed a total of 30,971 women aged 15 – 49 years and had a response rate of 91%. The sampling frame used for the 2011 MICS was the 2006 population and housing census of Nigeria conducted in 2006. The sample was selected using a multi-stage stratified cluster approach. It was implemented in 2011 with fieldwork taking place between February and March 2011. To ensure the quality of both surveys, training for fieldworkers was for 2 weeks. Team constituted of 1 supervisor, 1 measurer, 1 editor and 5 interviewers. Data entry was done using the CSPro software and all questionnaires were entered twice. Data quality was monitored by UNICEF Nigeria and UNICEF New York. Data were analyzed using the Statistical Package for Social Sciences (SPSS) software.

Other Sources (Non-survey sources):

For immunization coverage, coverage of Water and Sanitation interventions and Vitamin A Supplementation we used the WHO-UNICEF immunization coverage

estimate series (World Health Organization 2017), UNICEF Vitamin A supplementation data series (United Nations International Children's Emergency Fund (UNICEF) 2017), WHO-UNICEF Joint Monitoring Program on Water and Sanitation (JMP)(World Health Organization (WHO) and United Nations International Children's Emergency Fund (UNICEF) 2017). These provide yearly estimates of the coverage of these interventions at the national level.

Some LiST interventions (e.g., magnesium sulfate for pre-eclampsia, active management of the third stage of labor) are not readily measured through household surveys. In the absence of measured coverage data on these interventions, LiST estimates the coverage based on measured coverage of ANC4+ or of skilled birth attendance and facility delivery. We used this approach in our analysis as well. Where there is only one measure of a health indicator from all data sources, that value was maintained at the level across the years. Table 7 has a complete listing of health intervention and the data source.

Table 8: Definition of indicators and data sources

Intervention	Indicator definition used in model	Data Source	
		National Model	Subnational Model
Family Planning	Percent of currently married women using any modern method of contraception	NDHS 2008, MICS 2011, NDHS 2013	NDHS 2008, MICS 2011, NDHS 2013
Antenatal care (ANC 4+).	Percent of women who attend four or more antenatal care visits during their pregnancy	NDHS 2008, MICS 2011, NDHS 2013	Ratio's method*
Neonatal tetanus protection	Percent of neonates who are protected at birth (PAB) from tetanus infection	WHO-UNICEF coverage estimates series	Ratio's method
IPTp - Intermittent preventive treatment of malaria	Percent of pregnant women receiving 2+ doses of Sp/Fansidar during pregnancy.	NDHS 2008, MIS 2010, MICS 2011, NDHS 2013	NDHS 2008, MIS 2010, MICS 2011, NDHS 2013

Skilled Attendant at birth	Percent of children born with a skilled attendant present, including doctors, nurses, or midwives, in a facility or at home.	NDHS 2008, MICS 2011, NDHS 2013	NDHS 2008, MICS 2011, NDHS 2013
Facility delivery	Percent of children delivered in a health facility.	NDHS 2008, MICS 2011, NDHS 2013	NDHS 2008, MICS 2011, NDHS 2013
Early initiation of breastfeeding	Percent of children who begin breastfeeding within 1 hour of birth.	NDHS 2008, MICS 2011, NDHS 2013	NDHS 2008, MICS 2011, NDHS 2013
Exclusive breastfeeding	Percent of children receiving only breastmilk for food (plus medication, vaccines, and vitamins).	NDHS 2008, MICS 2011, NDHS 2013	NDHS 2008, MICS 2011, NDHS 2013
Vitamin A supplementation	Percent of children 6-59 months of age receiving two doses of Vitamin A during the last 12 months.	UNICEF Vitamin A supplementation data	Ratio's method
Improved water source	Percent of households with access to an improved water source within a 30 minute walk.	WHO/UNICEF JMP on Water and Sanitation (JMP)	Ratio's method
Improved sanitation	Percent of households using an improved sanitation facility	WHO/UNICEF JMP on Water and Sanitation (JMP)	Ratio's method
Hygienic disposal of children's stool	Percent of children's stools that are disposed of safely and contained.	NDHS 2008, MICS 2011, NDHS 2013	NDHS 2008, MICS 2011, NDHS 2013
Household ITN/IRS	Percent of households owning at least one insecticide treated bednet (ITN) and/or protected by indoor residual spraying (IRS).	NDHS 2008, MIS 2010, MICS 2011, NDHS 2013	NDHS 2008, MIS 2010, MICS 2011, NDHS 2013
Vaccine - DPT3	Percent of children who survive the first year of life who have received 3 doses of DPT vaccine.	WHO-UNICEF coverage estimates series	Ratio's method
Vaccine - Hib3	Percent of children who survive the first year of life who have received 3 doses of Hib vaccine.	WHO-UNICEF coverage estimates series	Ratio's method
Vaccine - Measles	Percent of children who survive the first year of life who have received 1 dose of measles vaccine.	WHO-UNICEF coverage estimates series	Ratio's method
ORS for diarrhea	Percent of children 0-59 months with suspected diarrhea treated with oral rehydration solution (ORS), including sachets or pre-mixed solutions.	NDHS 2008, MICS 2011, NDHS 2013	NDHS 2008, MICS 2011, NDHS 2013
Zinc for treatment for diarrhea	Percent of children 0-59 months with suspected diarrhea treated with 20mg of zinc daily.	NDHS 2008, MICS 2011, NDHS 2013	NDHS 2008, MICS 2011, NDHS 2013
Care seeking for pneumonia	Percent of children with suspected pneumonia (symptoms of acute respiratory infection) for whom advice or treatment was	NDHS 2008, MICS 2011, NDHS 2013	NDHS 2008, MICS 2011, NDHS 2013

	sought from a health facility or provider.		
ACTs for treatment of malaria	Percent of children treated within 48 hours of the onset of fever with an artmesinin-containing compound	NDHS 2008, MIS 2010, MICS 2011, NDHS 2013	NDHS 2008, MIS 2010, MICS 2011, NDHS 2013
Water connection in the home	WHO/UNICEF Joint Monitoring Program on Water and Sanitation (JMP)	WHO/UNICEF JMP on Water and Sanitation (JMP)	Not available

Analysis

Using data from the data sources listed above, seven different projections were created – one national and six sub-national (based on the six geo-political zones) projections. Each projection began with the available 2008 data to establish baseline coverage values for 2008. The data from 2011 were then entered and linearly interpolated with the values from 2008. Exceptions were in 2010 coverage values for the malaria indicators that were obtained from the 2010 Malaria Indicator survey. The end-line was set at 2013 and 2013 was entered and then interpolated from the 2011 data to obtain 2012 coverage values. Exceptions to this were for the national projection where data was obtained from WHO-UNICEF immunization coverage estimate series, UNICEF Vitamin A supplementation data series and WHO-UNICEF JMP on Water and Sanitation data that provided yearly estimates of coverage for the following interventions: Tetanus toxoid vaccination, Vitamin A supplementation, Improved water source, Water connection in the home, Improved sanitation and coverage of the following vaccines; BCG, Polio, DPT, Hib, Hepatitis B and Measles.

The sub-national projections were created using the sub-national wizard on the Spectrum software. The population of each zone was based off of the 2006 Nigeria national census accounting for population growth from 2006 to 2013. Coverage trends at the sub-national level were obtained from the surveys listed above. To be able to

compare the sub-national results to the national results, the ratio's method was used to the coverage of the following interventions; vaccines coverage, neonatal protection against tetanus, Vitamin A supplementation, and WASH interventions. In the ratio's method, a ratio between the subnational coverage rate and the national coverage rate (in the same household survey) was created and to the national coverage rate obtained from the non-survey sources. In some instances this approach resulted in coverage values greater than 100 percent, however coverage was capped at 100 percent in these instances. Given that there are wide variations in ANC coverage across the geo-political zones in the Nigeria, for example in 2013, percent of women who attended at least one antenatal care visit in the North-West was 41% and 90.6% in the South-East (Demographic 2013), and that the NDHS surveys do not provide ANC4+ coverage at subnational levels, the ratios method was used to obtain ANC4+ coverage at sub-national level for 2008 and 2013.

This analysis created 7 unique projections: one national projection and six subnational projection for changes in coverage of health interventions in Nigeria between 2008 and 2013. For each projection, LiST estimated the change in under-five mortality from 2008 to 2013, the total number of additional deaths prevented attributable to each intervention. The results of the estimates were added together along similar interventions into categories (See Table 2) for example, all number of additional deaths prevented attributable to the different vaccines (DPT3, Measles and Hib3) were grouped into Vaccines. Comparison were made between the results from all geo-political zones.

Table 9: Category of Interventions

Category	Interventions
WASH	Improved water source, Water connection in home, Improved sanitation, Hygienic disposal of children's stool
HIV	PMTCT, Pediatric ART care
Vaccines	DPT, Hib and Measles vaccine
Birthcare	Antenatal care, Skilled attendant at delivery, Facility delivery, Neonatal tetanus protection
Treatment of children	Case management of premature babies, neonatal sepsis/pneumonia, ORS and Zinc for diarrhea, Antibiotics for pneumonia, Artemesinin compounds for treatment of malaria
Child nutrition	Breastfeeding practices, Complementary feeding practices
ITN	ITN/IRS - Households protected from malaria

RESULTS

Figure 3 shows the trend in national coverage of various health interventions across the continuum of care for maternal, newborn and child health. With the exception of malaria prevention interventions, care seeking for pneumonia and Vitamin A supplementation, there was less than 10 percentage points change in maternal and child health interventions in Nigeria between 2008 and 2013. The most improved coverage of health interventions was Vitamin A supplementation which increased from zero percent coverage to 70 percent coverage in 2013. Malaria prevention interventions improved with percent of households which own at least one insecticide treated net or protected by indoor residual spraying increasing from 8 in 2008 to 50.1 in 2013. Coverage of pregnant women protected from malaria via intermittent preventive treatment of malaria using 2+ dose of SP or by sleeping under an insecticide treated net increased from 4.9 percent in 2008 to 16.4 percent in 2013 with a high of 34 percent in 2010. Haemophilus influenza type B (Hib) vaccine was

introduced in the country in 2012 and achieved a coverage rate of 30 percent in 2013 while the coverage of DPT3 and Measles vaccine gradually declined.

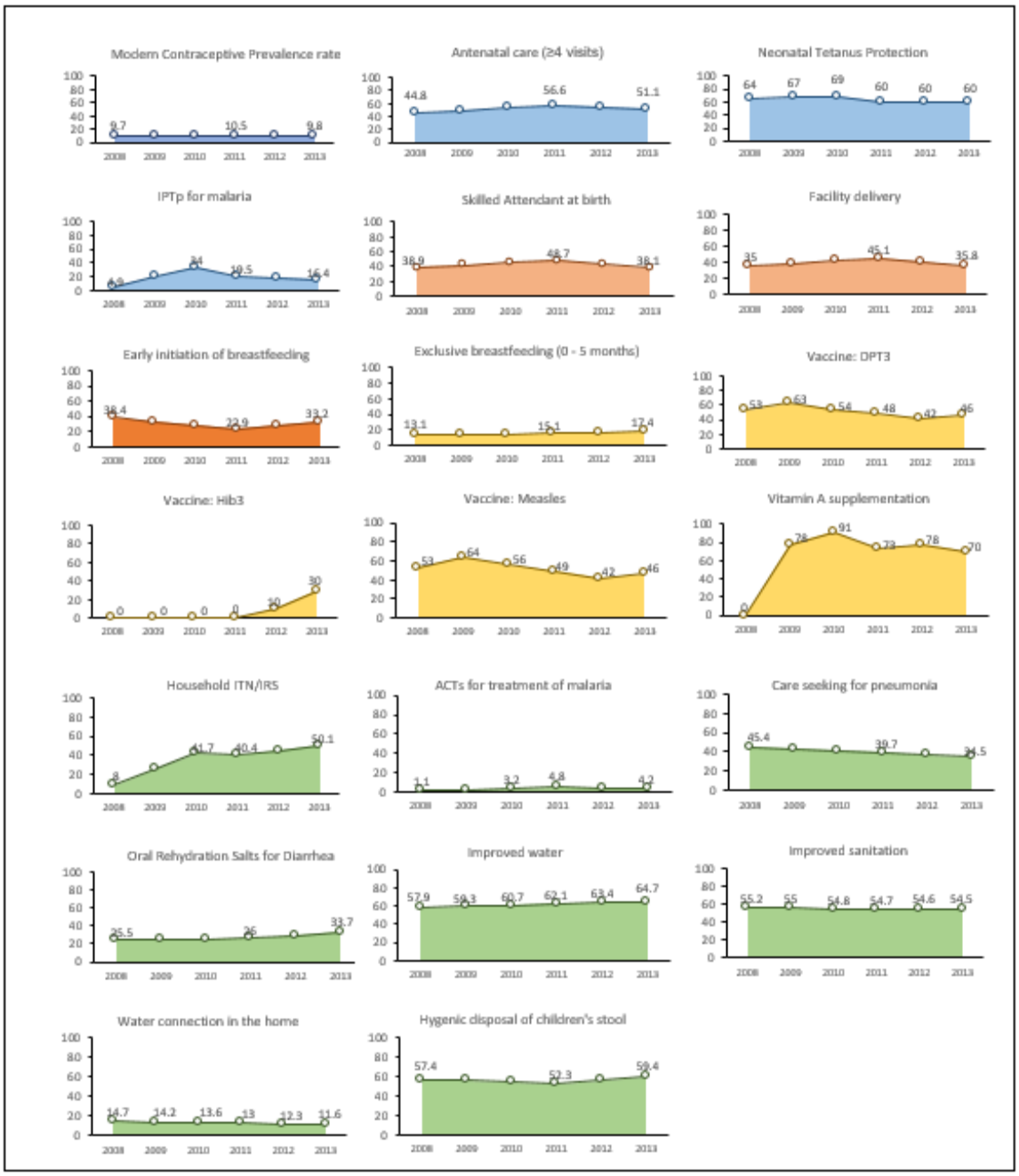


Figure 15: National trends in coverage (%) for the indicators along the continuum of care, 2008 – 2013.

Source is available in the appendix. DTP3=diphtheria-tetanus-pertussis 3rd dose, IPTp=intermittent preventive treatment in pregnancy, IRS=indoor residual spraying, ITN=insecticide-treated bednets, Hib3=Haemophilus influenza type B, third dose, ACTs=artemisinin-based combination therapy

Figure 16 shows additional number of lives saved by year with the most number of additional lives saved in 2010, with a 59 percent increase in additional lives saved between 2009 and 2010.

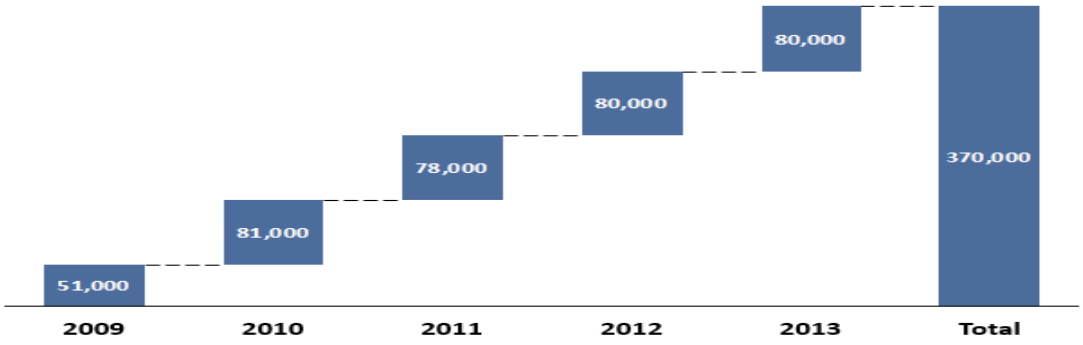


Figure 16: Cumulative additional Lives saved by year across all interventions

Figure 17 shows the total additional lives saved by intervention between 2008 and 2013. 50 percent of the total additional lives (185,000) saved between 2008 and 2013 were attributed to household protected from malaria either through ownership of at least one insecticide treated net or by indoor residual spraying. Another 25 percent was attributed to Vitamin A supplementation. Water, sanitation and hygiene (WASH) intervention resulted to lives lost with as much as 3 percent of additional lives saved lost to declines in coverage of WASH interventions.

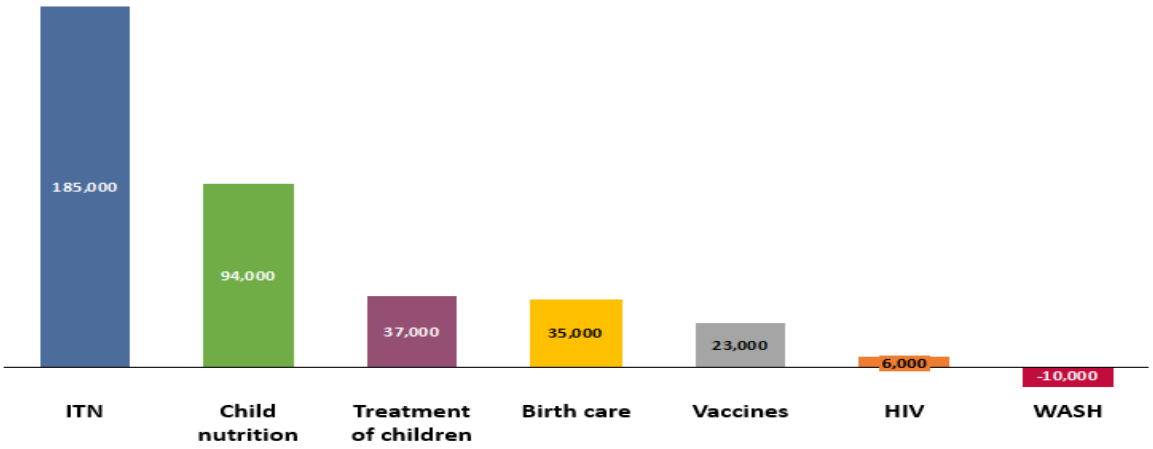


Figure 17: Total additional lives saved by intervention between 2008 and 2013

Across the years, household protection from malaria remains the health intervention with the most additional lives saved contributing to at least 45 percent with the exception of 2009. Additional lives saved from birthcare interventions started declining from 2011 with no additional lives saved attributable to birthcare interventions in 2013. Declines were also seen in additional lives saved from treatment of childhood illnesses (Figure 18).

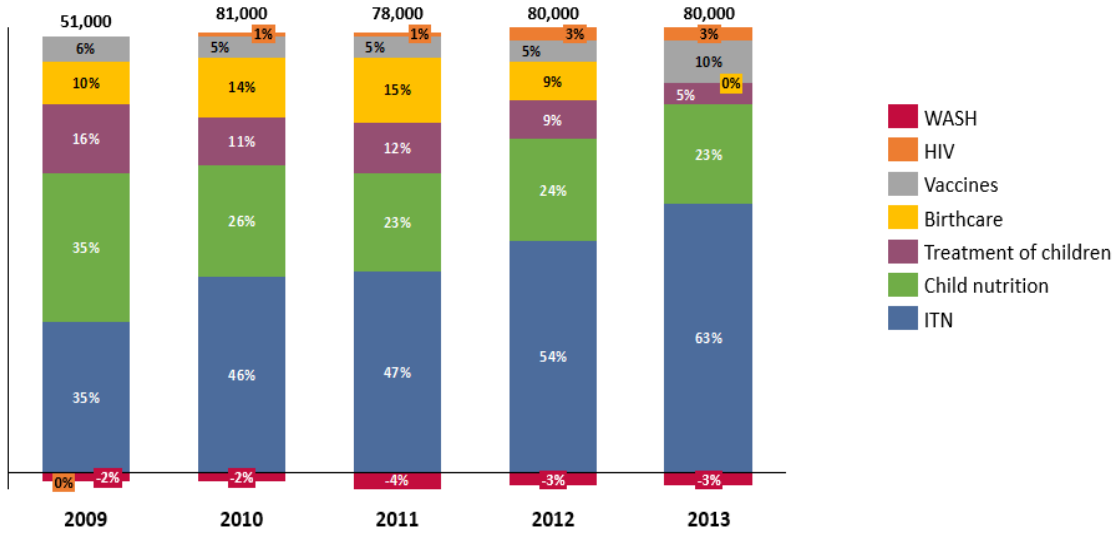


Figure 18: Additional lives saved by intervention by year

The findings from the sub-national analysis show that of the total additional lives saved between 2008 and 2013, 61 percent were from the North-East and North-West

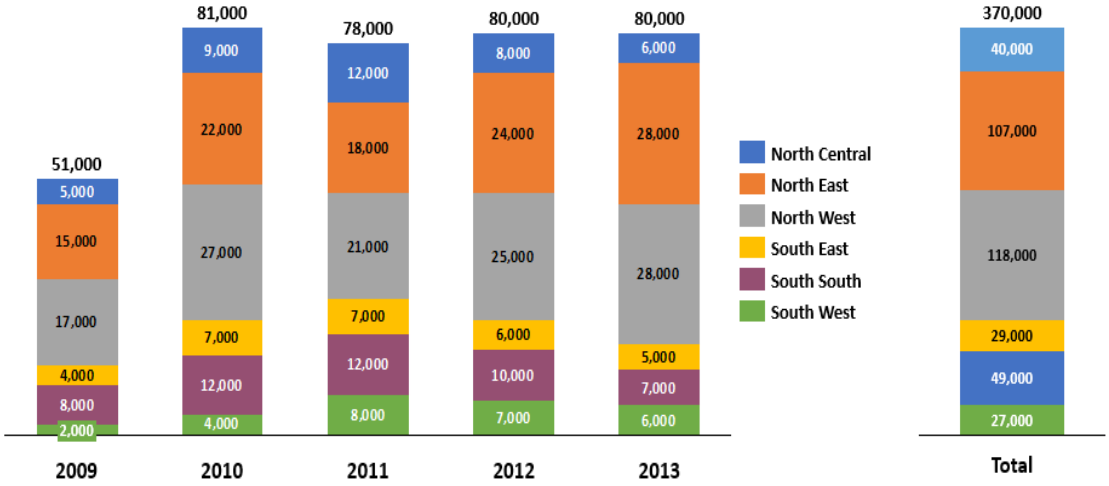


Figure 19: Total Additional lives saved by geo-political zone by year

geopolitical zones. On the average these two zones contributed to approximately 60 percent of total additional lives saved each year except in 2011 when they contributed to approximately 50 percent (see Figure 19).

By intervention, household protected from malaria either through ownership of at least one insecticide treated net or by indoor residual spraying contributed to the most additional lives saved across all geopolitical zones with the least (41 percent) in the South-South zone. Child nutrition also contributed to at least 13 percent in all zones. 10 percent of additional lives saved in the South-East were attributed to Vaccines while 15 percent of additional lives saved in the North-East were attributed to treatment of childhood illnesses. Contributions from birthcare interventions were significant in the North-Central (23%), South-East (14%) and South-South (24%) zones. When broken down to geo-political zones, the net loss of lives seen at the national level were attributable to all the zones in the North and the South-East while additional lives were saved from WASH interventions in the South-South (8 percent)

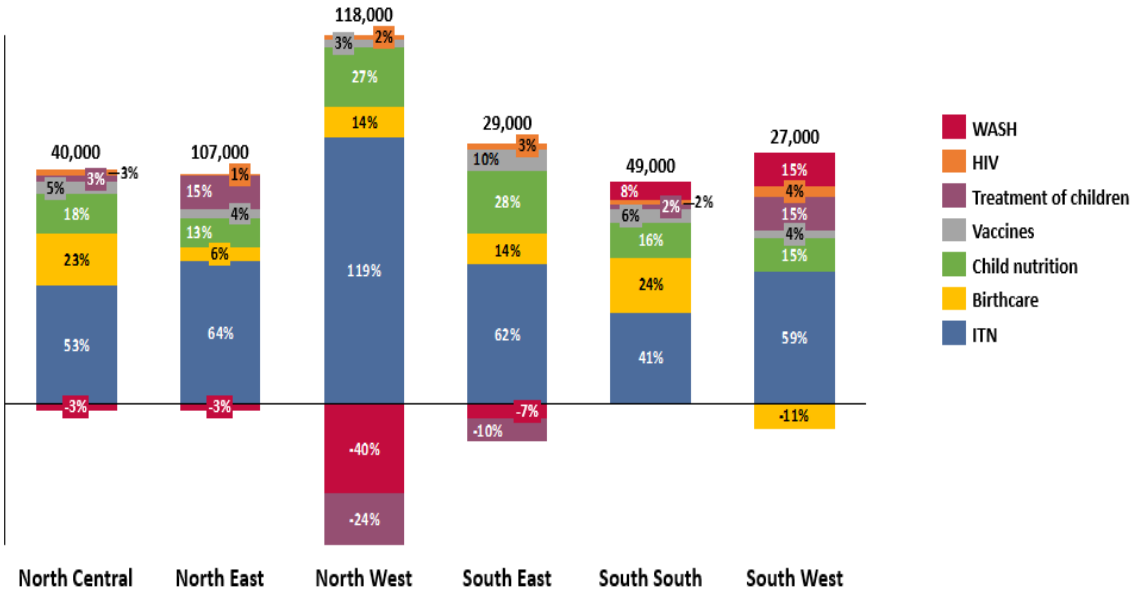


Figure 20: Total Additional Lives saved by intervention by geo-political zone

and South-West (15 percent) zones. Treatment of childhood illnesses also contributed to a net lives lost in the North-West (-24%) and South-East (-10%) zones while birthcare interventions contributed to a net lives lost in the South-West zone (-11 percent). (See Figure 20).

DISCUSSION

Despite the several programs aimed at improving the coverage of maternal and child health interventions in Nigeria, this has not been reflected by significant improvements in coverage. Coverage of several significant health interventions have actually declined. For example despite several programs targeting child immunizations, coverage of DPT3 and measles have actually declined across the years. With several programs targeting children under five years of age in Nigeria, changes in coverage of health interventions between 2008 and 2013 have been marginal. It is also important to acknowledge the effect of population growth. Nigeria population has been increasing with the population of children under five years of age increasing by about 77 percent between 1990 and 2013 (Gapminder 2017). This implies that even if the country maintained the same level of effort at coverage of health interventions, coverage will actually decrease as the target population is increasing at a high rate. The country will need to double its effort to maintain the same coverage rate across the years.

Between 2008 and 2013, Nigeria was able to save an additional 370,000 lives of children under five years of age from changes in coverage of health interventions targeting this age group. With the exception of a 59 percent increase between 2009 and 2010, there was little variance between the 2010 and 2013 ranging from 78,000 to 81,000 additional lives per year reflecting the marginal changes in coverage levels

between these years. This calls for a re-evaluation of the implementation of these programs. Understanding the drivers of demand and the barriers to access will be beneficial in developing new strategies that can drive the uptake of these health interventions. Also considering intervention that will target the increasing population of Nigeria will enable the country improve its coverage rates.

Most of the additional lives saved between 2008 and 2013 are attributable to the increase in coverage of households protected against malaria either through ownership of at least one insecticide treated net (ITN) or by indoor residual spraying. This is most likely due to the increased efforts of the National Malaria Elimination program in the distribution of ITNs through the universal mass campaign for ownership and use of the long lasting insecticide treated nets (LLINs), in Nigeria in May 2009 across the country (Ogundipe). This can also be explained by the approach of the NMEP. Most intervention programs are facility based and while components of the NMEP are facility based, it is mainly driven by community campaign and delivery of free commodities. The program has also enjoyed a high amount of donor support. Again, given that malaria accounts for 31 percent of deaths of children under five in Nigeria, interventions aimed at malaria will most likely yield the most number of lives saved. The increase in coverage of Vitamin A supplementation which contributed to approximately 25 percent of the total additional lives saved maybe linked to the introduction MNCH weeks. The MNCH weeks happens twice every year in each state and provides a simple delivery mechanism for interventions targeting children and mothers including Vitamin A supplementation (Visram, Jasper et al. 2014). This mechanism enables every child in the state with an opportunity to receive Vitamin A as it is also delivered as a campaign based program.

Coverage of water, sanitation and hygiene (WASH) interventions declined in Nigeria between 2008 and 2013 as the WASH program do not receive comparable backing and interest as other health programs (Ojo August 11 2016) despite the increase in population. The same way the LiST models increases in coverage as additional lives saved, it models decreases in coverage as lives lost. Thus the effects of this decline are reflected cumulatively as additional lives lost from WASH interventions. Additionally, the decline in additional lives saved from birthcare interventions from 2011 to 2013 is attributable to the declining coverage of neonatal tetanus protection across the years with marginal changes in coverage of other birthcare interventions.

The subnational analysis provided insights into the effects of the wide variations in coverage on health interventions across the zones. The results showed additional lives saved cumulatively from all six geo-political zones although the magnitude varied greatly between zones. The highest number of additional lives saved were from the North-West and North-East zones while the South-East and South-West zones had the lowest number of additional lives saved. The reasons for this are twofold. The North-West and North-East zones account for 40 percent of the entire Nigerian population and also have higher U5MR while the South-East and South-West zones account for 32 percent of the population and have better U5MR. Again, the baseline coverage levels of health interventions were higher in the southern zones compared to the northern zones. Thus the northern zones had more opportunities for additional lives saved than the southern zones.

Variances also existed in the magnitude of effect of the different health intervention across the zones. While additional lives saved by household protection against malaria

and child nutrition particularly Vitamin A supplementation were significant in all zones, differences existed in the effect of all the other interventions. Declining coverage of WASH interventions in all the zones in the North as well as the South-East lead to lives lost in these zones whereas these interventions were significant in saving additional lives in the South-South and South-West. Birthcare interventions contributed to lives saved in all the zones apart from the South-West given the declining coverage of birthcare interventions in this zone. Vaccines were a significant contributor to the number of lives saved in the South-East whereas none of the additional lives saved in the North-West were attributable to vaccines. Coverage of treatment of children curiously declined in the South-East as well as the North-West leading to lives lost from these interventions in these two zones. These additional lives lost are due to declines from the baseline coverage of these interventions in these zones. It is important to note that zones with very high baseline coverage particularly in the southern zones experienced additional lives lost from not sustaining these high coverage levels.

Limitations

With regards to the data used for the analysis, while the DHS reports mortality rates as the rates for the year in which the survey was conducted, the mortality rate are actually for the period of five years prior to survey. Hence the mortality rate for example reported in the 2008 DHS is the mortality rate between 2003 and 2008. However, this study looks at the change in the coverage of interventions and the number of lives saved by this change. A limitation of LiST projections is the fact that while demographic and coverage data used for projections are estimated from surveys,

country specific cause of death structures are modeled estimates while intervention effectiveness data are estimated from study results hence might not replicate the same effectiveness in an actual setting (Marsh, Munos et al. 2013). Again, for this study, the findings are dependent on the trajectory of coverage scale up between 2008 and 2013. While it may be most appropriate to use a linear scale up, it is unlikely that trends are in coverage scale up is linear. Instead scale-up curves are likely to be intervention-specific. For example, scale up of LLIN in Nigeria is mostly due to LLINs distributed in campaigns by the National Malaria Elimination Program in 2009 which would have resulted in a rapid increase in coverage then a much slowly increase till the next campaign therefore increases in ITN coverage prior to 2009 will not necessarily continue at the same rate after 2009. However, for this study the increase in coverage between 2008 and 2013 will be modelled as a linear increase except for years with actual coverage values. A major consideration in the interpretation of the results of a LiST analysis is that it only calculates additional lives saved from increase in coverage between baseline and endline i.e. it only shows the effects of incremental coverages of health interventions. It does not show the total number of lives saved by each intervention. This is important because while for example Vitamin A supplementation in our analysis saved 92,500 additional lives and Measles vaccine saved only an additional 2,000 lives, measles vaccines might have actually saved more total lives if you take the entire effect of the vaccine into consideration and not just the change in coverage. The accuracy of this analysis is also heavily dependent on the quality of the 2006 Nigeria population census which has been queried in the past (Makama 2007, Okafor, Adeleke et al. 2007, Vesperini 2007, Bamgbose 2009) as this builds the frame for not only the demographic data contained in the LiST but also

provides the sampling frame from which the sampling of the DHS survey was conducted. It is also important to acknowledge that the resultant effect of internal migration due to the Boko Haram insurgency in Nigeria (Isiugo-Abanihe 2016) have not been captured in this analysis.

CONCLUSION

These findings from this analysis suggest that while progress has been made on national and subnational levels to some extent, significant improvements need to be made to drive the uptake of health interventions in the country as coverage of health interventions have either stagnated or declined. This is particularly important as the country pushes towards the Sustainable Development Goals (SDG) which include all countries aiming to reduce under-5 mortality to at least as low as 25 per 1,000 live births by 2030 (United Nations 2015). Of importance is the decline in uptake of Water, Sanitation and Hygiene interventions and birthcare interventions particularly neonatal tetanus protection. These efforts need to specific to the geo-political zones in the country as wide variations exist in the coverage of health interventions across zones. Understanding the drivers of uptake of health interventions will help push this effort while maintain current efforts to sustain the gains from malaria prevention and Vitamin A supplementation in Nigeria. Further studies to understand the drivers of uptake of health interventions will be necessary to inform these efforts.

PAPER 3: Using the Missed Opportunity Tool – an application of the Lives Saved Tool (LiST) to prioritize intervention according to geo-political zones in Nigeria.

ABSTRACT:

Background: Under-five mortality remains high in Nigeria. In countries with high mortality, universal coverage of key health interventions e.g. care for newborns, infant and young child feeding; vaccines; management of pneumonia and diarrhea; malaria control etc. these interventions could reduce the number of under-five deaths by more than half. Wide variations exist in the coverage of these interventions across geo-political zones in Nigeria. Prioritizing interventions to scale up in each geo-political zone is an effective way to accelerate Nigeria's progress towards reducing under-five mortality. This study aimed to identify interventions with the highest impact in each geo-political zone in Nigeria.

Methods: A secondary analysis of population-based cross-sectional surveys using the missed opportunity tool in the Lives Saved Tool (LiST) was done to identify interventions with the highest impact for children under five years of age in each geo-political zone in Nigeria. Subnational LiST model based on the six geo-political zones were created using the 2013 Nigeria Demographic and Health Survey. A missed opportunity analysis was run and interventions with the highest number of deaths averted were identified.

Results: This study revealed ACTs for the treatment of malaria averted the most number of deaths across all geo-political zones. Water connection in the home was also a significant intervention across all zones. Facility management of labor and delivery were significant in the North-Central, South-South and South-West zones. The North-West and South-East zones had a similar profile of top ten interventions.

Conclusions: The missed opportunity tool provided an opportunity for evidence-based priority setting in Nigeria. However, prioritization of interventions depends on a whole host of factors – political will, policy options, cultural norms, and funding availability, amongst many other factors. Policy and decision makers should use these results to generate local discussions on how to implement, deliver, and sustain these programs in the context of the prevailing health system.

Keywords: Priority setting, Under-five mortality, Missed Opportunity, LiST, Nigeria

BACKGROUND:

The probability of a child dying before their fifth birthday (Under-five mortality) remains high in Nigeria. The aim of the Millennium Development Goal 4 (MDG4) which ran from 2000 – 2015 was to reduce mortality in children younger than 5 years by two-thirds between 1990 and 2015 (UN General Assembly 2000). Nigeria did not meets its MDG4 target (Oleribe and Taylor-Robinson 2016). With an under-five mortality rate (U5MR) of 128 deaths per 1,000 live births (Demographic 2013), Nigeria (13%) along with India (21%) account for more than one-third of all deaths among children below 5 years of age (WHO 2015c). Reduction of under-five mortality remains on the global agenda with the Sustainable Development Goals (SDG) including all countries aiming to reduce under-five mortality to at least as low as 25 per 1,000 live births by 2030 (United Nations 2015). Achieving this goal will require universal coverage of key health interventions e.g. care for newborns, infant and young child feeding; vaccines; management of pneumonia and diarrhea; malaria control etc. In countries with high mortality, these interventions could reduce the number of under-five deaths by more than half (WHO 2015b).

Nigeria is made up of 36 states and a Federal Capital Territory grouped into six geo-political zones based on proximity: North-Central, North-East, North-West, South-East, South-South, and South-West. The heterogeneity of Nigeria presents a situation that requires different solutions for reducing under-five mortality within the country. This is because wide variation exists within the geopolitical zones and the individual states in the country. Northern zones and states are faring poorer than southern zones and states in terms of both health outcomes and coverage of health interventions as can be seen in the 2013 Nigeria Demographic and Health Survey (NDHS). For example, U5MR in the North-West zone is 185 per 1,000 live births while it is 90 per 1,000 live births in the South-West zone, and in terms of health intervention coverage, in the North-West zone only 10% of children in the age group of 12-23 months are fully vaccinated, as compared to almost 41% in the South-West zone (Demographic 2013). This calls for prioritizing health policies and programs by their effectiveness in reducing under-five mortality in each geo-political zone.

Various priority setting tools exist to guide policy and decision makers to assess the potential impact and effectiveness of health interventions on mortality reduction. The Lives Saved Tool (LiST) which enables the modelling of context-specific effectiveness of health interventions is able to conduct prioritization of health interventions both at the national and subnational levels (Rudan, Kapiriri et al. 2010). The Lives Saved Tool is a multi-cause model of mortality that predict changes in under-five and neonatal mortality rates and deaths, maternal mortality ratios and deaths, stillbirth rates and deaths, causes of death using country specific health status, changes in child and maternal health intervention coverage levels i.e. ORS, facility delivery, etc. and effect sizes of interventions based on the best available evidence (Walker and Walker

2014). Groups have used the LiST to retrospectively attribute the causes of measured or observed declines in mortality to specific activities (Afnan-Holmes, Magoma et al. 2015). Mortality reductions estimated by LiST have performed well when compared against measured data following the scale-up of packages of child survival interventions in various settings and the tool has been validated in African and South Asian settings (Amouzou, Richard et al. 2010, Friberg, Bhutta et al. 2010, Hazel, Gilroy et al. 2010, Amouzou, Habi et al. 2012). Studies have also shown where LiST has been used to make decisions for planning health programs in countries like Burkina Faso, Ghana, Malawi, Ethiopia, and South Africa (Bryce, Friberg et al. 2010, Onarheim, Tessema et al. 2012, McGee, Chola et al. 2015). A quick automated analysis called Missed Opportunity is available as a new tool in LiST to use to identify and prioritize health interventions. It assesses the impact of each interventions in the LiST on mortality. Based on existing coverage, if there is no universal access to these interventions, the potential deaths averted will become "missed opportunities". It enables the user to prioritize health interventions based on their impact.

Given that Nigeria did not meet the MDG 4 target, it becomes pertinent to identify the interventions that can significantly contribute in accelerating the rate of the decline in under-five mortality to enable the country achieve the SDG 3 target. While geo-political zones are for administrative and demographic purposes and health intervention programs are not designed by zones, it is important to study the effectiveness of different health interventions in the different geo-political zones in Nigeria and how they contribute to the declining U5MR. This might provide the evidence for addressing the varying coverage of health interventions and health outcomes across the different geo-political zone.

This paper looks to provide information on the interventions that might be most effective in each geo-political zone based on the current coverage level of the intervention. This will provide the much needed evidence base required by the country to accelerate the decline of U5MR. The Missed Opportunity results will be used to compare the relative impact of interventions, and to prompt contextualized discussions towards prioritization of intervention each geo-political zone in Nigeria.

METHODS:

Study design

This is a secondary analysis of population-based cross-sectional surveys (NDHS 2013) using the Missed Opportunity tool within the Lives Saved Tool (LiST) to prioritize health interventions for the different geo-political zones in Nigeria. This analysis is done at the subnational levels of geo-political zones.

Setting

This is study in set in Nigeria, officially the Federal republic of Nigeria. With a 2013 estimated population of approximately 173 million inhabitants, Nigeria is the most populous country in Africa and the seventh most populous country in the world (World Bank 2015b). According to the most recent population censes, the population is spread out across the six geo-political zones as follows; North-West (26%), North-East (14%), North-Central (14%), South-East (12%), South-West (20%) and South-South (15%) (NPC Nigeria 2007). United Nations estimates that the population in 2009 was at 154,729,000, distributed as 51.7% rural and 48.3% urban, and with a population density of 167.5 people per square kilometer (Babalola 2012). National census results

in the past few decades have been disputed because census figures are used to determine regional funding and representation of ethnic and religious groups in government service. This provides an incentive for inflating local populations. Census figures are believed to have been manipulated in the past for political advantage (Bamgbose 2009). According to 2013 NDHS (Demographic 2013) children under -five accounted for 17% of the Nigeria population which makes every unit change in mortality to reflect great effect in the population. The health indices are characterized by wide regional disparities and are generally better in the southern than the northern zones (Demographic 2013).

Data sources

LiST analysis require the population coverage of health intervention to project the effect of changes in coverage on the health outcome of interest. Coverage of health intervention is measured as the proportion of those needing an intervention who receive it. For this study coverage level of the various interventions were obtained from the NDHS 2013:

NDHS 2013

The 2013 NDHS was implemented in 2013 with fieldwork taking place between February and June 2013. The sampling frame used for the 2013 NDHS was also the 2006 population and housing census of Nigeria conducted in 2006, however, a stratified three-stage cluster design was consisting of 904 clusters, 372 in the urban and 532 in the rural areas was used to select the sample. A representative sample of 40,680 households was selected and the survey interviewed 39,902 women aged 15 –

49 and 18,229 men aged 15 – 59 in these households across the 36 states and federal capital territory of Nigeria. The response rate for the 2013 NDHS was 99% and there was no significant difference between rural and urban areas in terms of response rates (Demographic 2013).

To ensure the quality, training for fieldworkers was for 4 weeks and the survey team constituted of 1 supervisor, 1 field editor, 4 female interviewers, and 2 male interviewers. The survey used quality controllers made up of the technical team and trainers. Quality was also monitored using field check tables that were generated concurrently with data processing operations and by external bodies. Specifically, the quality controllers made sure that that the correct numbers of questionnaires and eligible respondents were used, checked that all questionnaires were entered and ensured that all questionnaires were entered twice, verified by comparing both data sets and all discrepancies were resolved. Survey used the CSPro computer package for data processing.

Missed Opportunity Tool:

The Spectrum software is a suite of policy models that is free and publicly available for use, and provides the necessary demography, HIV/AIDS, and family planning information and data for mortality impact modeling in LiST (Stover, McKinnon et al. 2010). LiST projects mortality impact of women, stillbirths, and children based on changes in coverage of interventions that have a proven effect on reducing cause-specific mortality. Projections can be created using country-specific inputs to model the impact of about 70 maternal and child health interventions (Walker, Tam et al. 2013). The Missed Opportunity tool, housed within the LiST module of the Spectrum

software, automates the process of scaling up coverage of each of the 70 interventions individually to a target coverage at scale, and rank the interventions according to the magnitude of deaths averted by the interventions. The process in which the Missed Opportunity tool produces results is exactly the same as creating 70 individual projections in LiST and scaling up one intervention in a projection at a time. Spectrum version 5.57 was used for this analysis to look at missed opportunities in the six geo-political zones in Nigeria.

For this analysis, subnational LiST models were created using coverage data from the 2013 NDHS for each of the six geo-political zones. Coverage of each intervention in LiST was then scaled up from its current coverage to 90% in the next year, while assuming coverage of all other interventions stay constant at its current coverage until the next year using the missed opportunity tool. 90% was chosen as the default target coverage at scale as it is an aspirational but achievable target, as evidenced by the coverage achieved by DPT3 vaccination in many low and middle income countries (WHO 2016). Any interventions with coverage at or above 90% was left as is and not scaled down. For each of the six projections created, the missed opportunity tool ranked the interventions according to additional deaths prevented.

RESULTS:

The top ten missed opportunities for children under five years of age are shown by intervention in Figures 1 to 6 for the six geopolitical zones.

Table 1 shows the top five Missed Opportunities across all age groups by geo-political zone. ACTs (Artemisinin Combination Therapy) for the treatment of malaria rank highest as the top intervention for averting total deaths across all geo-political zones.

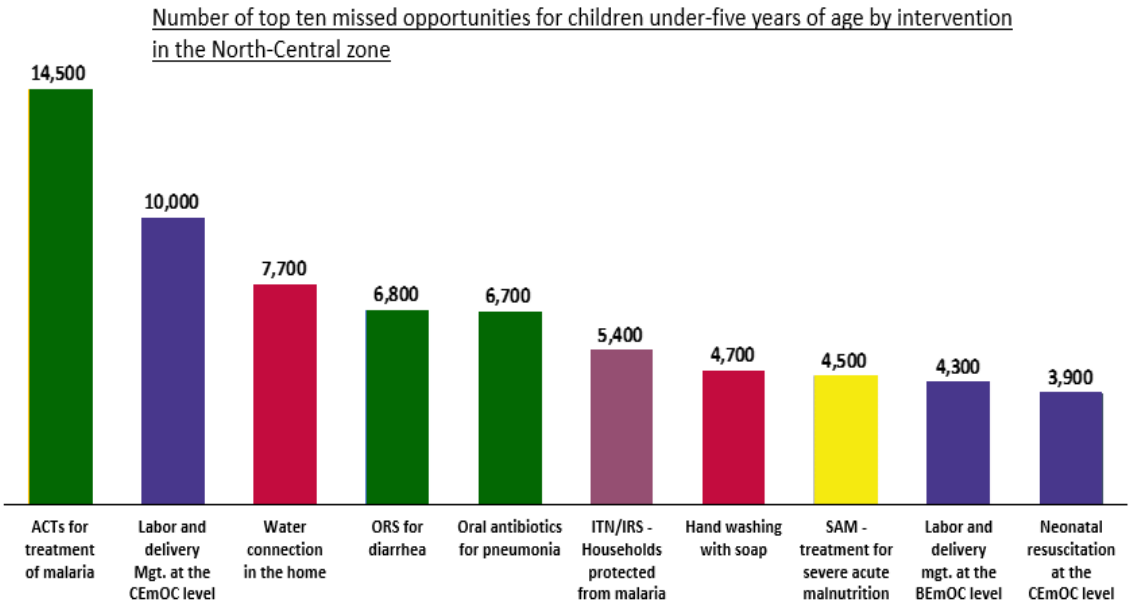


Figure 21: Top ten missed opportunities for children under-five years of age by intervention in the North-West zone

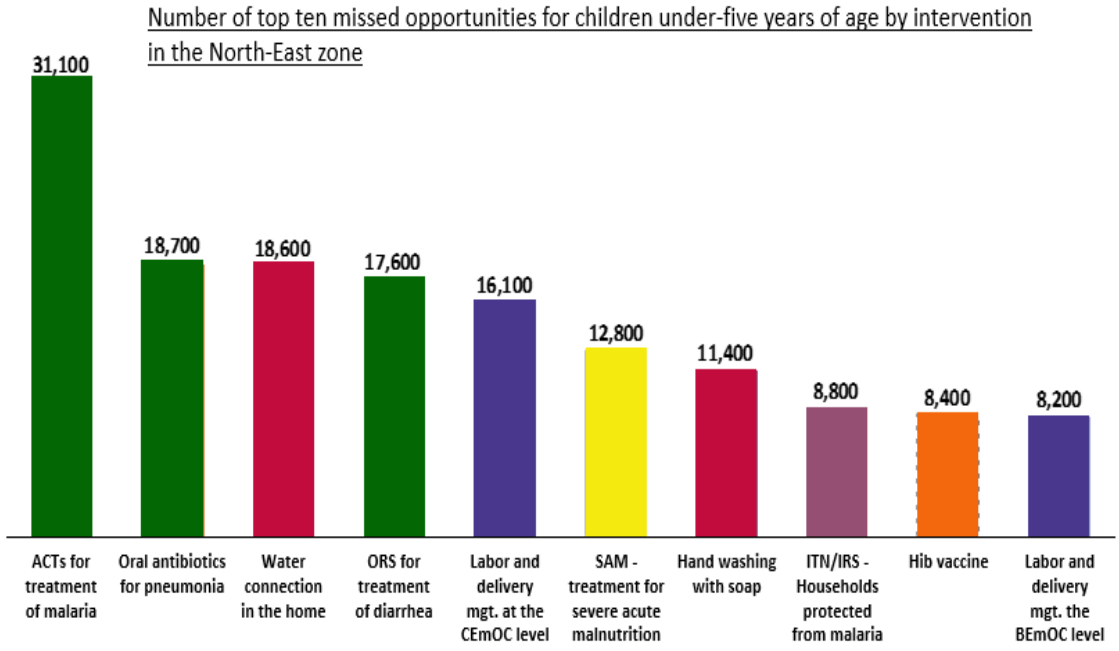
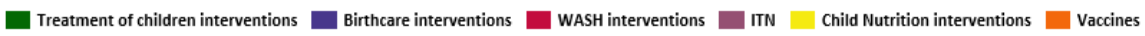


Figure 22: Top ten missed opportunities for children under-five years of age by intervention in the North-East zone

Categories of intervention



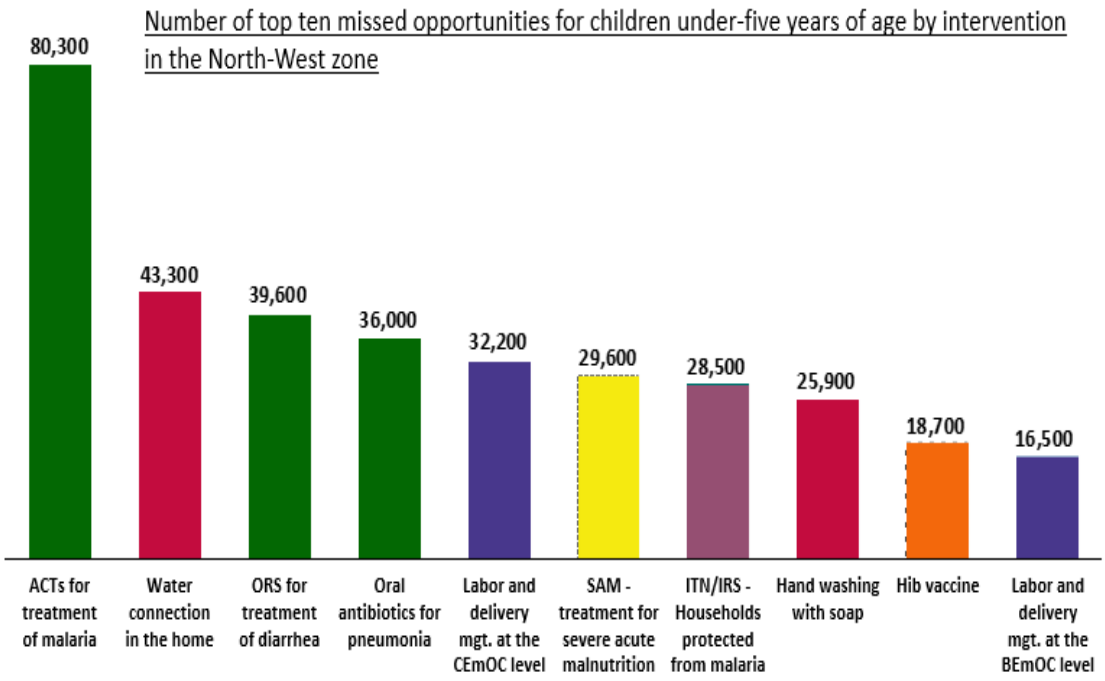


Figure 23: Top ten missed opportunities for children under-five years of age by intervention in the North-West zone

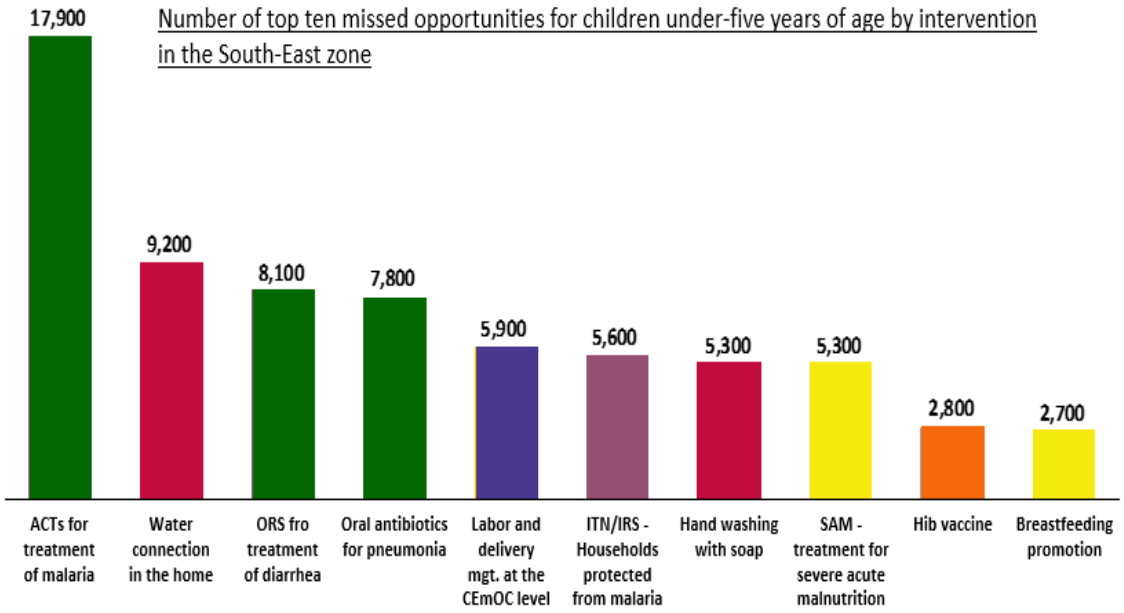
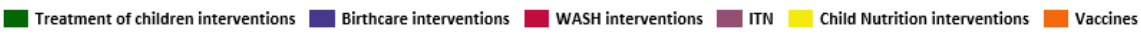


Figure 24: Top ten missed opportunities for children under-five years of age by intervention in the South-East zone

Categories of intervention



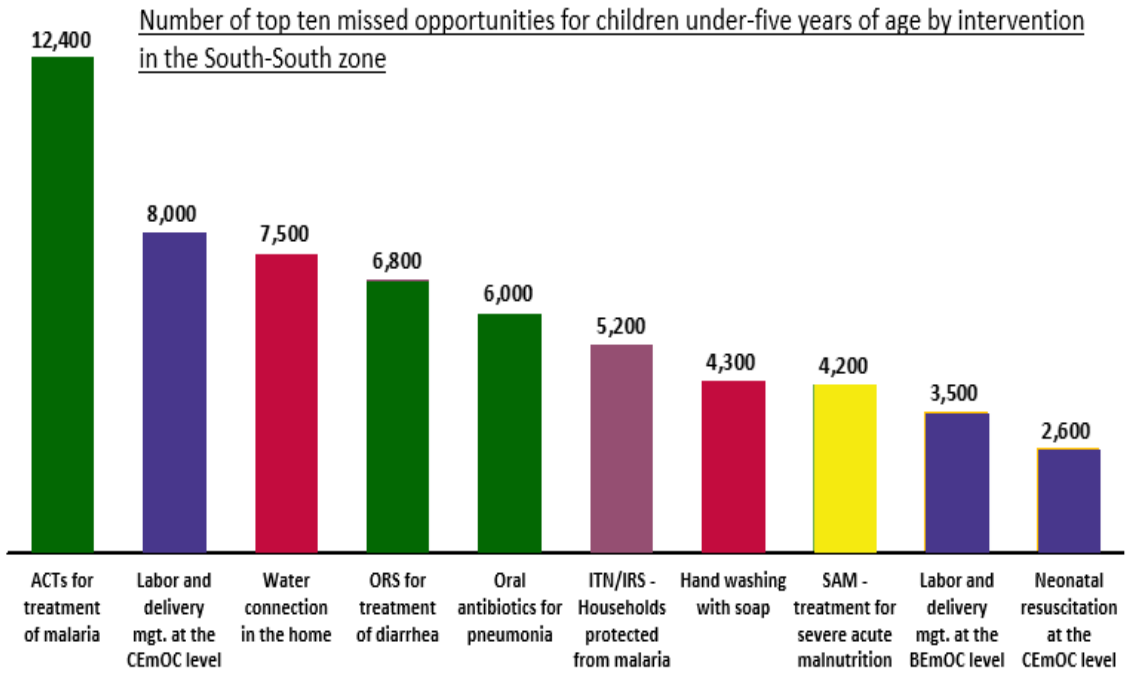


Figure 25: Top ten missed opportunities for children under-five years of age by intervention in the South-South zone

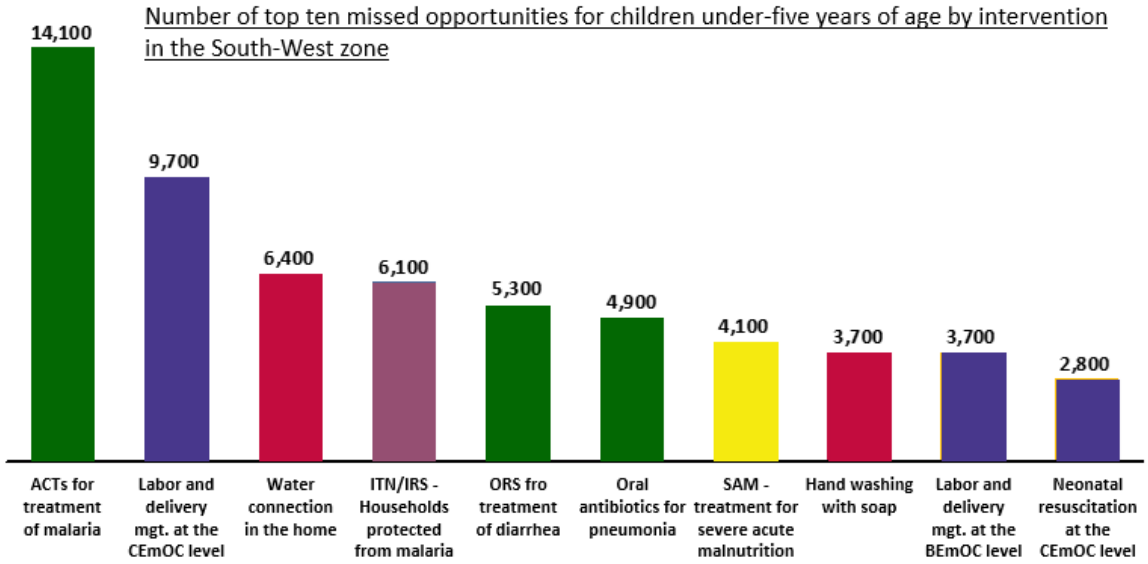


Figure 26: Top ten missed opportunities for children under-five years of age by intervention in the South-West zone

Categories of intervention

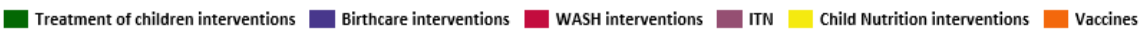


Table 10: Top five missed opportunity for children under five years of age by geo-political zone

	North-Central zone	**North-East zone**	**North-West zone**	**South-East zone**	**South-South zone**	**South-West zone**
1	ACTs for treatment of malaria	ACTs for treatment of malaria	ACTs for treatment of malaria	ACTs for treatment of malaria	ACTs for treatment of malaria	ACTs for treatment of malaria
2	Labor and delivery management at the CEmOC level	Oral antibiotics for treatment of pneumonia	Water connection in the home	Water connection in the home	Labor and delivery management at the CEmOC level	Labor and delivery management at the CEmOC level
3	Water connection in the home	Water connection in the home	ORS - oral rehydration solution for treatment of diarrhea	ORS - oral rehydration solution for treatment of diarrhea	Water connection in the home	Water connection in the home
4	ORS - oral rehydration solution for treatment of diarrhea	ORS - oral rehydration solution for treatment of diarrhea	Oral antibiotics for treatment of pneumonia	Oral antibiotics for treatment of pneumonia	ORS - oral rehydration solution for treatment of diarrhea	ITN/IRS – Households protected from malaria
5	Oral antibiotics for treatment of pneumonia	Labor and delivery management at the CEmOC level	Labor and delivery management at the CEmOC level	Labor and delivery management at the CEmOC level	Oral antibiotics for treatment of pneumonia	ORS - oral rehydration solution for treatment of diarrhea

Water connection in the home also ranked high across all geo-political zones being second in the North-West and South-East zones and third in all the other zones.

Labor and delivery management at the Comprehensive Emergency Obstetric Care (CEmOC) level ranked second for the North-Central, South-South and South-West zones. Labor and delivery management at the Basic Emergency Obstetric Care

(BEmOC) level and neonataol resuscitation at the CEmOC level also ranked among the top ten in these three zones. These are health facility-based interventions that are highly effective at saving lives (Lee, Cousens et al. 2011, Yakoob, Ali et al. 2011, Zaidi, Ganatra et al. 2011, Pollard, Mathai et al. 2013, Bhutta, Das et al. 2014). Hand washing with soap was another intervention that ranked among the top ten in all six geo-political zones. Household protection from malaria either through an insecticide treated net (ITN) or through indoor residual spraying (IRS) also ranked high in all zones. Treatment of childhood illnesses through either oral antibiotics for pneumonia, and oral rehydration solution for diarrhea (ORS) were also significant across the zones.

In terms of similarity, the North-West and South-East zones had similar intervention rankings differing only with treatment of severe acute malnutrition bring higher ranked in the North-West than households protected from malaria in the South-East zone. The North-Central zone and the South-South zone had the same ranking for all top ten missed opportunities.

DISCUSSION:

This paper set out to prioritize health interventions by the geo-political zones in Nigeria using the missed opportunity tool. As expected, interventions with low current coverage that are highly effective at reducing main burden of diseases emerged as the largest missed opportunities. Malaria accounts for 31 percent of deaths of children under five (WHO 2014) and coverage of treatment of malaria using ACTs remain low (Demographic 2013). As such ensuring that children with malaria receive ACTs should be a priority for the country in all the zones. It is important to point out that though the missed opportunity tool scales up the interventions one at

time, it is hardly possible to have programs that focus one specific interventions. For example, program will most likely not focus on treatment of malaria with ACTs without trying to improve coverage of malaria prevention interventions. This will definitely have an impact on the number of lives saved from treatment of malaria using ACTs.

As seen from the results, facility-based interventions and treatment interventions were the most impactful in averting deaths. Water and sanitation also were impactful in averting deaths particularly water connection in the home. Despite high coverage of interventions in the South-East and low coverage in North-West, both zones had a similar profile for interventions to prioritize. This similarities might be due to the lack of data on the differential cause of death structure across the two zones or due to the actual quality of interventions being received in each zone.

Prioritization of interventions depends on a whole host of factors – political will, policy options, cultural norms, and funding availability, amongst many other factors. The Missed Opportunity analysis provide decision makers the number of potential lives saved as the normative factor to prioritize high impact interventions that are evidence-based. However, scale-up of these interventions heavily depend on health system readiness and require multi-sector collaboration, it is also important to involve non-health partners in discussion and planning of these scale-up. As the country and states are in the process of developing the national and state strategic health development plan, it is important to consider these interventions that will yield the highest impact.

Feasibility of implementation is also important in looking at the results of this analysis. Although the missed opportunity analysis scales up coverage of intervention in isolation of others, hardly are interventions delivered in isolated circumstances. For example, Integrated Management of Childhood Illnesses (IMCI) encompasses management of all childhood illness including malaria, pneumonia and diarrhea. It is also important to point out that this analysis reports additional lives saved thus does not intend to make a case for stopping the provision of other health interventions. The author still supports the delivery of preventive and treatment interventions to combat multiple diseases through a horizontal, primary health care system (Victora 2010). Synergy in delivery of health interventions will still be more impactful than focusing on individual interventions.

Limitations of the Missed Opportunity Tool

A major limitation of this study is the assumption of the same cause of under-five structure across all geo-political zones. While prevalence of some disease may not vary across the zones e.g. measles, others may vary e.g. malaria. Validity of the results depends on the input data used. Since coverage estimates from household surveys are collected from a few years prior to publication, assuming that coverage of interventions generally increases over time, using older estimates will overestimate the impact of intervention scale-up. This analysis also made assumption that the health interventions received were delivered with the best quality. Finally, while lives saved are a quantifiable factor to justify prioritization, it does not suggest the necessary steps for a health system to achieve and sustain universal coverage of interventions. For example, promoting universal coverage of the top missed

opportunity – ACTs for treatment of malaria – will likely involve discussions such as economic and cultural barriers to access care.

CONCLUSION:

With the wide variation in coverage of health interventions across geo-political zones in Nigeria, the missed opportunity tool provided an opportunity for evidence-based priority setting. ACTs for treatment of malaria emerged as a priority for all zones. Water and sanitation interventions particularly water connection in the home also emerged as a top priority in all zones. Facility based interventions regarding management of labor and delivery were top interventions North-Central, South-South and South-West zones. However, decision and policy makers should use these results to generate local discussions on how to implement, deliver, and sustain these programs in the context of the prevailing health system.

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Curriculum Vitae

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Profile

A public health professional of over 11 years' experience in developing, implementing, monitoring and evaluating public health programs for health improvement. Expertise in using the Lives Saved Tool to assess potential number of lives saved by various health intervention programs. Knowledgeable and experienced in HIV/AIDS, Malaria, Tuberculosis, Maternal and Child health, Performance Based Financing and Behavioral Change Communication public health programs.
Currently running a doctoral program with the International Health department at Johns Hopkins University.

Education

Doctor of Public Health (DrPH) – International Health — in view

Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

Masters of Public Health (MPH) — May 2009

Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

Bachelor of Medicine and Bachelor of Surgery (MBBS) — July 2005

College of Medicine, University of Nigeria, Enugu State, Nigeria

Professional Experience

Senior Associate, — January 2015 till date
Health Strategy and Delivery Foundation (HSDF),
Abuja, FCT Nigeria

Main Duties

Performance Management Specialist:

Designing and instituting performance management cycles with individual states in the country where states agree on set targets, collate information and data on their

progress and address bottlenecks towards achieving those set targets while improving availability and validity of their data sources with the overall goal of causing a paradigm shift from input based programming to output based programming

Lives Saved Analysis:
Running a national and state level analysis of the number of lives saved by various health intervention programs in the country and building the capacity of government officials to run the analysis using the Lives Saved Tool

Monitoring and Evaluation:
Collating and analyzing available national data sources like household surveys and routine program data and translating these data to communication tools for evidence based decision in health care management in Nigeria as well as assessing progress on core health indicators.

SMART surveys:
Providing technical expertise and insight in the nutrition based SMART surveys in order to expand the scope and content of the survey with an aim to provide more frequent health utilization information in the country for all the states of the federation

Research Studies:
Leading efforts on providing more information for better health programming through research in conjunction several strategic partners.

Consultant, April 2014 – June 2014
World Bank,
Washington DC, USA

Main Duties

- To explore the option of a Quantitative Supervisory Checklist approach for the Saving One Million Lives Initiative (SOML)
- Assess the currently available data sources for the M&E system for the SOML
- Assess the resources needed to scale up various data sources
- Explore the need for developing an explicit performance management plan for the SOML

Consultant, July 2013 – June 2014
Saving One Million Lives Initiative, Program Delivery Unit
Solina Health/Federal Ministry of Health, Nigeria, Abuja, FCT Nigeria

Main Duties

- Provide services as a Performance management officer for the SOML initiative
- Carry out a national analysis using the Lives Saved Tool (LiST) for the Saving One Million

Lives Initiative (SOML) in Nigeria
- Conduct state level analysis using LiST in Nigeria
- Build capacity of the SOML/FMOH staff on using LiST
- Recommend data sources for monitoring and evaluating the SOML Initiative

Monitoring and Evaluation Manager: July 2011 – Aug 2012
Country Coordinating Mechanism (CCM) Nigeria
For Global Fund Grants on AIDS, TB and
Malaria Abuja, FCT, Nigeria

Main Duties

- Set up and oversee the implementation of an M&E system to monitor Global Fund AIDS, TB and Malaria grants by principal and sub recipients (PRs and SRs) in Nigeria.
- Collaborate with the Federal Ministry of Health and National Disease Control Programs and Agencies to conduct gap analysis, proposal development and Requests for Continued Funding for Global Fund grants
- Monitor progress and develop means of assessing impact of Global Fund grants on the national level
- Build capacity of PRs and SRs on Global Fund grant monitoring and evaluation processes
- Avail the CCM the required human resources for proper monitoring and evaluation through collaborations with bilateral and multilateral partners to utilize their technical expertise in creating task teams for the various disease components.
- Provide technical M&E/oversight input to CCM Oversight Committee with regard to development of appropriate schedule of activities to effectively oversee implementation of current GF Grant portfolio and assessment of organizations capacity to implement Global Fund grants
- Support the CCM Oversight committee to develop, cost and implement its annual oversight plan and integrate it into CCM work-plan and budget
- Maintain and operationalize the CCM grant dashboards and database
- Develop summary analysis reports and archives of dashboards and PU/DRs to facilitate CCM Oversight committee meetings
- Provide CCM members and Oversight committee members with appropriate reports and other information pertaining to national monitoring and evaluation, data verification principles and current practices.
- Harmonize Global Fund grant's data with national strategic plan

Monitoring and Evaluation Officer (HSS): Jan 2010 – June 2011
Family Health International (FHI)
Anambra Zonal Office, Anambra State, Nigeria
Main Duties

- Collaborated with staff of the State Ministries of Health and HIV/AIDS agencies

in designing and implementing M&E systems and to conduct monthly M&E meetings, using results generated from their facilities to effect evidence based healthy public health policies.

- Facilitated capacity building of facility and partner staff on the Malaria, TB and HIV/AIDS, control program, Maternal and Child health programs as well as reproductive health services
- Conducted trainings for government staff to build capacity on improved service delivery and M&E best practices
- Supported in coordinating and writing activity reports and worked towards ensuring effective implementation and reporting of the project's program activities.
- Assisted in developing sub agreements (M&E frameworks) for Implementing Agencies by setting out targets for the different aspects of the project and developing ways to monitor such targets.
- Identified, developed and maintained systems for data collection and maintenance
- Worked with other zonal M&E staff to provide overall guidance on program/project monitoring and evaluation according to the US Government, Global Fund and Government of Nigeria reporting requirements.
- Provided support to the 11 facilities in the zone, including site visits and interacting with state health ministries and management boards, agencies, site Program Managers, Implementing Agencies and facility Monitoring and Evaluation staff, consultants and FHI partners so as to ensure they understood and could support these requirements.
- Worked with other team members in M&E to develop performance monitoring frameworks including indicators, activities, targets and reporting timelines to ensure that zonal M&E activities are appropriate and met donor and project M&E needs
- Provided technical assistance for real time electronic data entry for patient encounters using the LAMIS software
- Conducted routine Data Quality Assessments (DQA) as prescribed under current standard operating procedures using the electronic DQUAL tool.
- Coordinated data entry into DHIS 1.4 and DHIS 2.0, generating pivot tables and charts for data presentations
- Coordinated the M&E processes for Behavioral Change Communication (BCC) activities within the zonal office including coordinating visits from donor agencies

Sr. Research Program Coordinator Sept. 2009 – December 2009
Dept. of Rheumatology, School of Medicine Johns Hopkins University
Baltimore, Maryland, USA

Main Duties

- Coordinated clinical research activities for the Johns Hopkins Lupus Center.
- Monitored progress of various research protocols for multicenter studies and collected and interpreted research data on patients entered into research protocols.

- Achieved a target of enrolling 300 patients into a study in a year within 2 months using inter personal relationship skills

Research Assistant March 2009 – August 2009
Center for Injury Research and Policy
Johns Hopkins Bloomberg School of Public Health Baltimore, Maryland, USA

Main Duties

- With the Center for Injury Research and Policy where I assisted in a community based intervention trial for Injury prevention in Baltimore, MD., developing a database administering surveys and collecting and entering data. The trial is still in progress.
- Also assisted with coordination of the data collection.

Medical Doctor October 2006 – March 2008
Crescent Clinic, Abuja, Nigeria National Assembly Clinic Abuja (NYSC)
Jessie Memorial Hospital Uga, Anambra State

Main Duties

- Attended to patients with minor and major illnesses and assisted in major surgeries e.g. Caesarean Section, Prostatectomy and Appendectomy.
- Conducted key community outreaches and volunteer duties which included health education on safe health practices, outpatient services and distribution of health aids. Aimed at improving access to health care and health education.
- Led the team that harmonized patient management and monitoring tool for the clinic as was assigned by the Medical Director of National Assembly Hospital, Abuja during my service year.
- At Jessie Memorial Hospital, was the Resident medical officer for the hospital which was in a rural community in the state and successfully led the hospital to integrate the services of the Traditional Birth Attendants (TBAs) into the hospital services. Came up with a program plan whereby the TBAs could help their clients access services that they could not provide like HIV screening and birth control services. Supervised the hospital staff, delegated duties and motivated staff by commending diligent staff.
- Was also instrumental in generating data from the medical records unit to help initiate evidence based decisions

House Officer (Intern) September 2005 – September 2006
Nnamdi Azikiwe University Teaching Hospital
Nnewi, Anambra State

- Provided medical care in Urology, assisted in the Orthopaedic, Plastic and General Surgery medical care. Attended to Paediatrics patients in Neonatology (Newborn). Provided medical care in Obstetrics and Gynaecology (PMTCT unit) with particular emphasis on enrolling HIV
  positive women in and making sure they remain on HAART and Internal medicine (Renal/HIV unit), duties included providing health care for patients at different stages of renal disease and HIV infections.

- Developed reports and presentations during clinical meetings.

Publications

- An Assessment of Data Availability, Quality, and Use in Malaria Program Decision Making in Nigeria: Kelechi Ohiri, Ndukwe Kalu Ukoha, **Chike William Nwangwu**, Charles Chikodili Chima, Yewande Kofoworola Ogundeji, Alero Rone, and Michael R. Reich. Health Systems & Reform Vol. 2, Iss. 4,2016
- Influence of Organizational Structure and Administrative Processes on the Performance of State-Level Malaria Programs in Nigeria: Ndukwe Kalu Ukoha, Kelechi Ohiri, Charles Chikodili Chima, Yewande Kofoworola Ogundeji, Alero Rone, **Chike William Nwangwu**, Heather Lanthorn, Kevin Croke, and Michael R. Reich. Health Systems & Reform Vol. 2, Iss. 4,2016

Certificates

- Nigerian Medical and Dental Council – Full Registration, 2006
- Certificate in Research Ethics – Johns Hopkins Bloomberg School of Public Health, November 2008
- Specialty Certificate in Occupational and Environmental Health – Johns Hopkins Bloomberg School of Public Health, April 2009
- Specialty Certificate in Clinical Vaccine Trials and Good Clinical Practice – Johns Hopkins Bloomberg School of Public Health, May 2009
- Certificate of Course Completion in Global Health for Family Planning Legislative and Policy Requirements and M&E Frameworks for HIV/AIDS Programs, September 2010
- Certificate of Merit for completion of the SINA Health International Performance Based Financing (PBF) course, July 2016

Skills/Languages

- Computer: Proficient in Microsoft Word, Excel, & PowerPoint, STATA
- Languages: Fluent in English, Fluent in Igbo